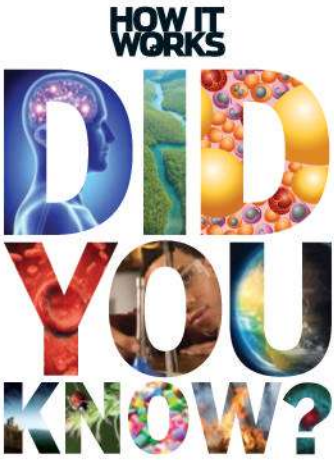
NEW

HOW IT WORKS

Revealing the truth behind life's biggest mysteries

Welcome to



It is possible to 3D print your own car from an open source design? A Nobel Prize was awarded to the scientists who described the physics behind hula-hooping? Earth isn't the only planet to have naturally occurring auroras such as the Northern Lights? There is technology that gives you powers like Spider-Man? All this and more are explained inside the pages of this book, pursue knowledge like never before.

Imagine Publishing Ltd
Richmond House
33 Richmond Hill
Bournemouth
Dorset BH2 6EZ
☎ +44 (0) 1202 586200
Website: www.imagine-publishing.co.uk
Twitter: @Books_Imagine
Facebook: www.facebook.com/ImagineBookazines

Publishing Director
Aaron Asadi

Head of Design
Ross Andrews

Production Editor
Jen Neal

Senior Art Editor
Greg Whitaker

Designer
Abbi Denney

Photographer
James Sheppard

Cover images courtesy of
NASA, Thinkstock, Dreamstime

Printed by
William Gibbons, 26 Planetary Road, Willenhall, West Midlands, WV13 3XT

Distributed in the UK, Eire & the Rest of the World by:
Marketforce, 5 Churchill Place, Canary Wharf, London, E14 5HU
Tel 0203 787 9060 www.marketforce.co.uk

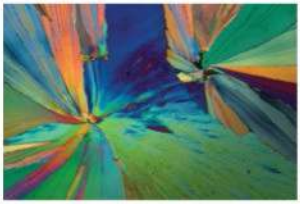
Distributed in Australia by:
Network Services (a division of Bauer Media Group), Level 21 Civic Tower, 66-68 Goulburn Street, Sydney, New South Wales 2000, Australia Tel +61 2 8667 5288

ISBN 9781785461453

Part of the
HOW IT WORKS
book series

IMAGINE PUBLISHING

Contents



Science

Transport

Technology

Contents

Environment

Space

History

DID YOU KNOW...

There are 206 bones in the human body

The 206 bones of the adult human skeleton make up a strong, flexible framework that protects our vital organs and allows our bodies to move, as well as being a mineral store and stem-cell reserve.

Bone is a composite material, constructed from three basic ingredients: collagen strands, a sugary protein glue and inorganic calcium salts. The collagen fibres are arranged in alternating layers, crossing over one another, providing a flexible scaffold, and calcium salts are glued in between for strength and rigidity.

The outside of each bone is composed of plates, or hollow tubes, of dense cortical bone, supported on the inside by a honeycomb network of spongy trabecular bone. This network is slightly flexible and helps to distribute the load, curving the tensile and compressive forces across the ends of the bone, while providing maximum strength.

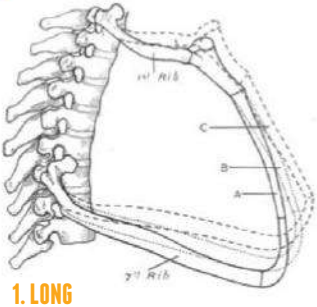
Spongy bone is also home to the bone marrow, and which houses stem cells capable of producing most of the cells of the blood and immune system. They are constantly active, and millions upon millions of new red and white blood cells are produced every minute.

Embedded within the bone matrix are cells known as osteocytes. They do not move, but are capable of detecting stresses inside the bone itself, and can trigger the formation of new bone in a process known as remodelling. The old bone is broken down by large cells known as osteoclasts, and new collagen and minerals are deposited by smaller osteoblasts.

Together, the two cell types are able to release and store calcium and phosphorous in the skeleton for use elsewhere in the body. They are under the influence of hormones released by glands in the brain, and when levels of minerals run low in the body, the signals encourage the osteoclasts to begin wearing away at the surface of the bone, releasing minerals into the bloodstream. When mineral levels are high, osteoblasts lay down new bone, replenishing the store.

The major function of the skeleton is to provide a structural framework for the muscles that move our bodies

LONG BONES



1. LONG SEVENTH RIB

The seventh rib, which is the lowest fixed rib, is the longest bone in the rib cage, measuring about 24cm (9.5in) in length.

2. LONGER HUMERUS

After the three leg bones, the next-longest bone in the human body is the humerus in the upper arm, measuring around 36cm (14in).

3. LONGEST FEMUR

The femur, or thigh bone, is the longest bone in the human body by some margin, measuring around 50cm (20in) in the average adult.

"The two cell types are able to release and store calcium and phosphorous in the skeleton"

DID YOU KNOW...

BONE STRUCTURE

ARTICULAR CARTILAGE
The end surfaces of the bones are covered in thick, slippery cartilage, preventing wear at the joints

COMPACT BONE
The outside of the bone is arranged in an orderly, layered structure, providing strength and rigidity

EPIPHYSIS
The ends of the long bones act as shock absorbers, with a casing of tough compact bone supported by a spongy core

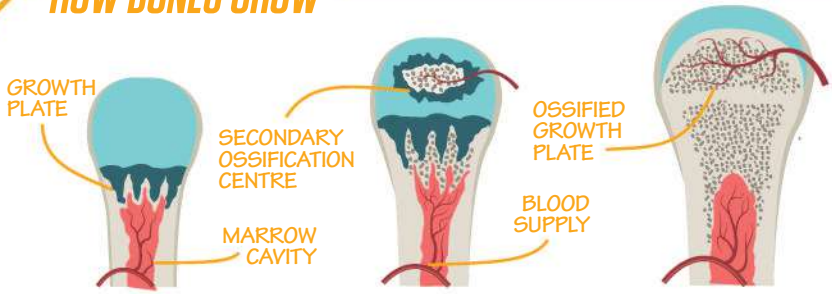
PERIOSTEUM
The outside of the bone is covered in a layer of connective tissue, containing cells involved in growth and repair

Cells known as osteoclasts constantly remodel the surface of bone

DIAPHYSIS
The shafts of the long bones are constructed from densely packed compact bone

MEDULLARY CAVITY
The centre of the long bones is filled with yellow bone marrow, containing mainly fat cells

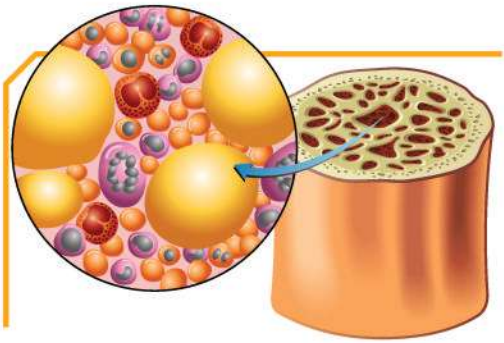
HOW BONES GROW



NEWBORN
In the womb, most of the skeleton is made of cartilage, but gradually minerals are laid down and it is converted to bone in a process known as ossification.

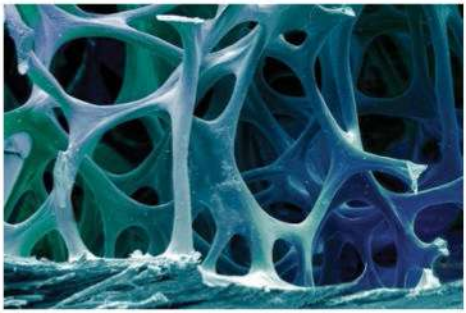
CHILD
Cartilage continues to form at the growth plates, and calcium salts are added at the secondary ossification centre, lengthening the bone at both ends.

ADULT
The growth plate itself is turned to bone, and stops producing cartilage, preventing the bones from lengthening any further.



BONE MARROW CELLS

There are two types of bone marrow in the human body; yellow marrow is found in the shafts of the long bones, like the femur, and red marrow is mainly found in the flat bones, like the ribs. Yellow marrow is mostly made up of large fat cells, whilst red marrow contains stem cells. These are capable of producing most of the cells of the blood and immune system, and concealed within the bones are many immature cells in the process of development.



Spongy bone has a characteristic honeycomb structure

RED BONE MARROW
Blood cells are produced in red bone marrow, found between the gaps in the honeycomb structure of the spongy bone at either end

BLOOD VESSELS
Blood vessels travel into and out of the bone through canals in the compact surface

ENDOSTEUM
The inner surface of the bone is lined by a single layer of cells

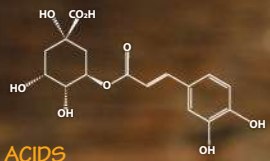
SPONGY BONE
This disorganised honeycomb structure is more flexible than compact bone, and its large surface area supports blood-cell production and calcium exchange

DID YOU KNOW...

Caffeine is an alkaloid

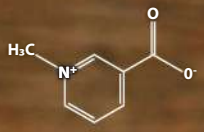
Whether it's a milky latte or a double shot of espresso, coffee has become an important morning ritual for many people all over the world. Its rich taste and aroma serves as a welcoming wake-up call and the caffeine helps keep you alert for the rest of the day, but did you know this is all down to the 1,000 different chemical compounds present in every cup? Acids, alkaloids, carbohydrates and proteins, either found in raw coffee beans or produced by the roasting process, work together to create a complex mixture of flavours and that distinctive coffee smell.

WHAT'S IN YOUR CUP?



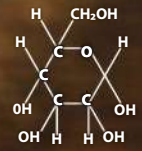
ACIDS

Coffee contains a variety of acids. Perhaps the most important is chlorogenic acid, which consists of two main compound groups. Dicaffeoyl acids impart a metallic, bitter taste while monocaffeoyl acids slowly decompose during the roasting process. This causes them to split into quinic and caffeic acids, which contribute to the coffee's bitter aftertaste.



ALKALOIDS

Although caffeine is probably the best-known alkaloid in coffee, Trigonelline prevents mucus-like acid by-products and other bacteria from sticking to your teeth, helping to prevent cavities. The roasting process creates aromatic compounds called pyridines. Pyridines are responsible for the coffee's sweet, earthy taste.



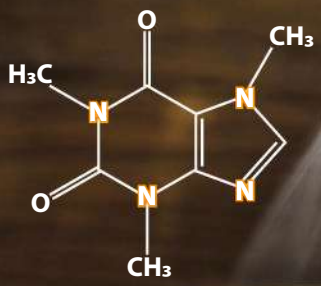
CARBOHYDRATES AND PROTEINS

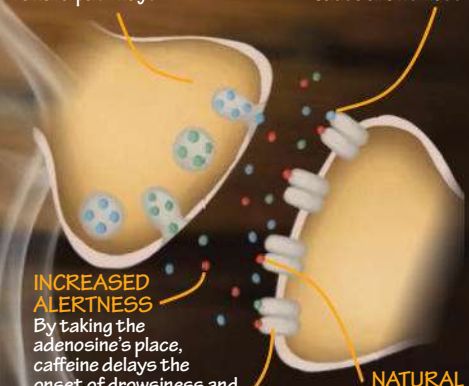
Carbohydrates make up about 50 per cent of coffee's dry weight. They play an important role in the production of coffee's distinct aroma by way of the Maillard reaction, which takes place during the production. When the beans are roasted their free proteins combine with their sugars to form aromatic compounds.

CAFFEINE

Caffeine is a naturally occurring alkaloid acts as a stimulant for the human brain. As a result, the adrenal glands also produce adrenaline, the body's 'fight-or-flight' hormone, which causes your pupils to dilate, blood to flow to your muscles and sugar to be released into your bloodstream by your liver. When caffeine enters the body, enzymes in the liver also break off three metabolites from its compound structure. Theobromine increases oxygen and nutrient flow to the brain, paraxanthine increases the rate of fat breakdown to fuel muscle activity and theophylline increases your heart rate and reinforces concentration.

The recommended daily limit of caffeine intake is 400 milligrams (0.014 ounces), which is about three 237-millilitre (eight-ounce) cups of coffee, but if you were to consume more than ten grams (0.35 ounces) – that's about 75 cups of coffee – in a day, then it would become toxic and could lead to heart problems.





DOPAMINE REGULATION
Adenosine is also responsible for regulating dopamine in the brain, the hormone that activates pleasure centres and reward pathways

WITHOUT COFFEE
Normally, adenosine molecules bond to receptor cells in the brain to slow down nerve activity and cause drowsiness

INCREASED ALERTNESS
By taking the adenosine's place, caffeine delays the onset of drowsiness and increases alertness

WITH COFFEE
As caffeine is very similar in structure to adenosine, it can bind to the adenosine receptor cells and block the adenosine

NATURAL STIMULANT
Dopamine works more effectively while the adenosine receptors are blocked, contributing to that pleasant coffee 'buzz'

DID YOU KNOW...

Identical twins don't have identical fingerprints

Identical twins form when a single fertilised egg splits in two during the early stages of development, and as a result, the siblings share exactly the same genetic information. But our bodies are shaped not only by our genes, but also by our environment, and although the twins share the same womb, their environments are subtly different. Each twin is in a different position, and experience slight variations in contact with amniotic fluid. One might have a longer umbilical cord than the other, and one might receive more oxygen or nutrients. Fingerprints develop during the second trimester, and these small differences add up to produce noticeably different fingerprints.

Even if you can't tell the difference immediately, their fingerprints will give them away

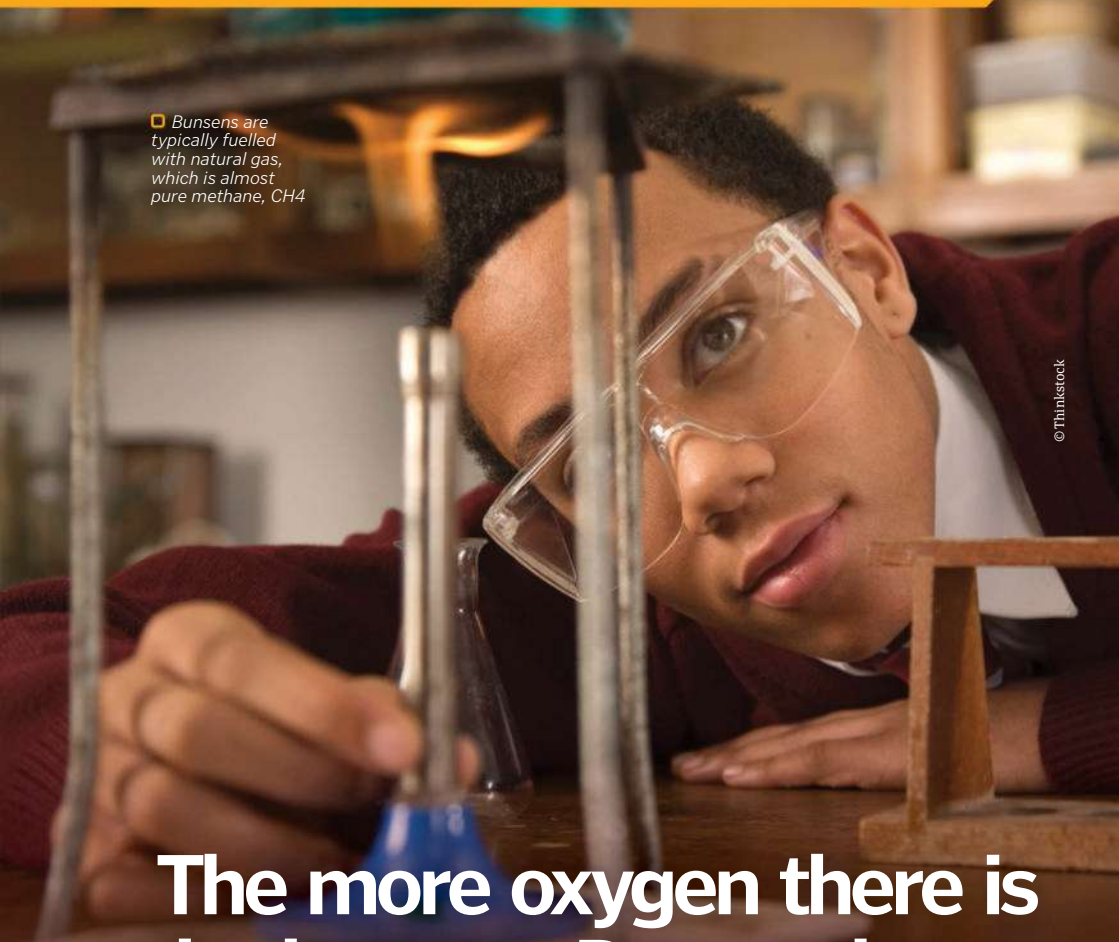
Cold feet are caused by reduced blood circulation

© Dreamstime/Thinkstock

Cold feet are typically caused by reduced blood circulation. When your body is cold, it constricts your blood vessels, reducing blood flow to your skin in order to conserve heat around your internal organs.

In some people this reaction, called vasoconstriction, is triggered even at relatively warm temperatures, leading to cold feet and hands.

Cold extremities are quite common in cooler weather and are unlikely to indicate any serious medical condition. However, if they go white you may be suffering from Raynaud's phenomenon, a condition where arteries cut off almost all circulation to hands and feet in cold temperatures.



Bunsens are typically fuelled with natural gas, which is almost pure methane, CH_4

The more oxygen there is the hotter a Bunsen burns

German chemist Robert Bunsen invented the Bunsen burner in the mid-19th century as a means to an end. His work focused on emission spectra, which is the bright light produced by different elements when they are heated in a flame. To carry out this experiment he required a hot, clean flame, which gave him the idea for the Bunsen burner. A modern Bunsen burner consists of a straight metal tube, measuring about 13 centimetres (five inches) long, attached to a base stand. A thin rubber tube known as a gas hose connects to the bottom and supplies gas to the Bunsen. The metal collar works to adjust the amount of air that enters the tube by altering the size of the air hole at the base. By allowing oxygen to mix with the gas, a hotter and more complete reaction occurs, causing a very hot, blue flame to be produced. It still has an abundance of laboratory applications today, including sterilisation and fixing cells to microscope slides.

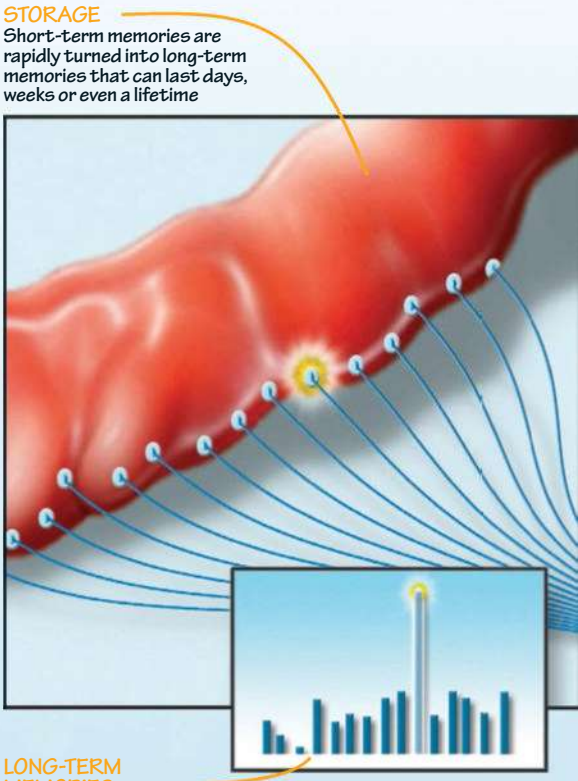
DID YOU KNOW...

Your Hippocampus turns short-term memories into long-term ones

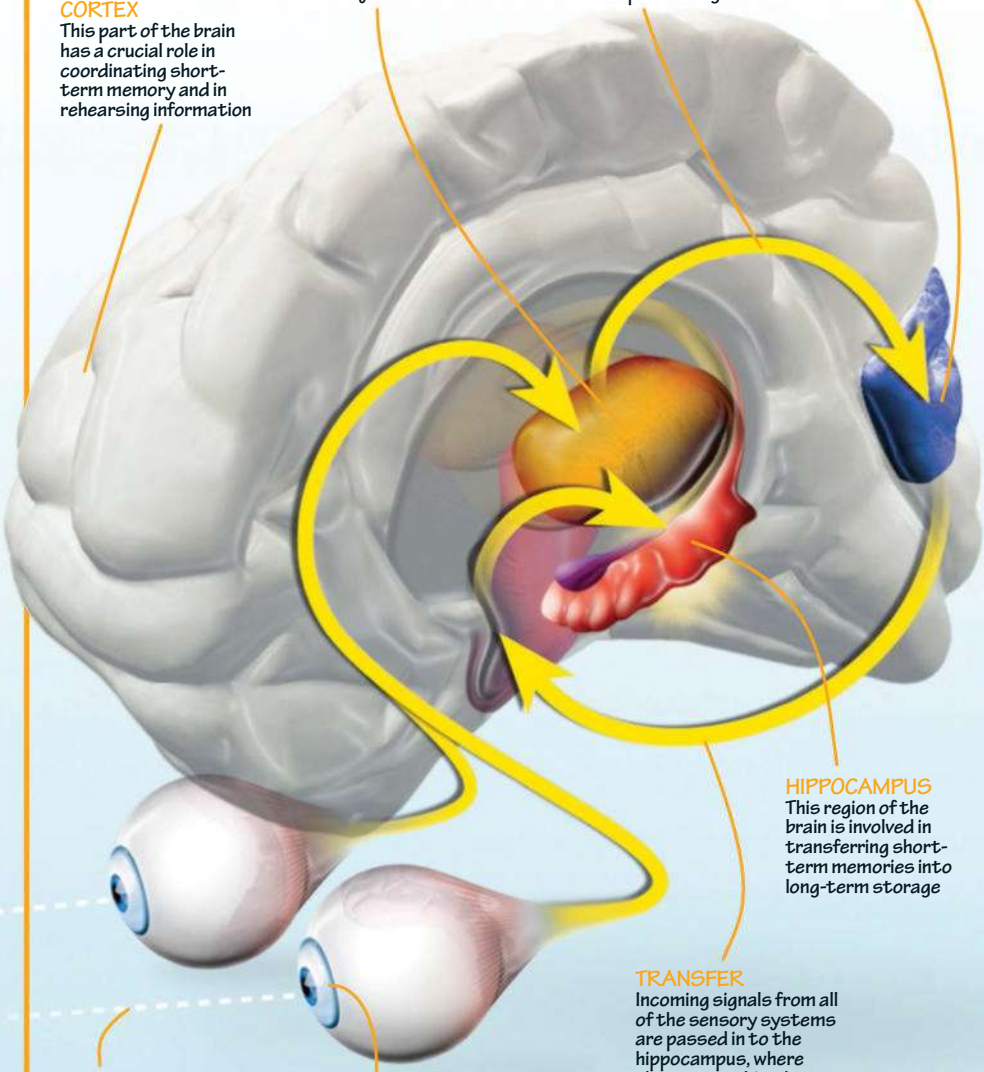
As you read this article, you store the words at the beginning of each sentence in your short-term memory while you work your way through to the end, enabling you to understand the text. At the same time, you are probably ignoring the feeling of the glossy pages against your skin as you hold the bookazine.

Short-term memory acts somewhat like a gatekeeper between incoming sensory information and long-term storage. You are constantly bombarded by information, and the incoming traces from your sensory receptors last for just fractions of a second before they are lost. You don't have time to process all of it; so short-term memory allows you to pass small amounts of important information in a temporary loop while your brain decides what to do with it.

Short-term memory has two major limitations; the first is that you can only store a small amount of information, and the second is that the memory decays over time. If you pay attention, your short-term memory can hold around four chunks of new information for between ten and 20 seconds, but if you are distracted, you will rapidly forget it all. Rehearsing the information inside your head effectively resets the timer and restarts the memory loop, allowing you to extend this time. A part of the brain called the hippocampus then decides which bits are important enough to be committed to longer-term storage, and the others are quickly forgotten.



MAKING MEMORIES



PREFRONTAL CORTEX
This part of the brain has a crucial role in coordinating short-term memory and in rehearsing information

THALAMUS
The thalamus is involved in attention and the early stages of short-term memory formation

PROCESSING
The incoming signals from the eyes are passed to the occipital lobes for processing

OCCIPITAL LOBE
The occipital lobes process incoming visual information

HIPPOCAMPUS
This region of the brain is involved in transferring short-term memories into long-term storage

TRANSFER
Incoming signals from all of the sensory systems are passed in to the hippocampus, where they are combined as a single 'experience'

INPUT
Incoming information is stored for less than a second in your sensory memory

ATTENTION
In order to transfer information from sensory memory to short-term memory you need to be paying active attention

DID YOU KNOW...

We are genetically programmed to prefer sweet food

We are born biologically programmed to like sweet, fatty foods; it is an evolutionary hangover dating back to our early primate ancestors. In the past, the desire to eat high-calorie food would have been critical for our survival, driving us to seek out foods that would have provided a lot of energy, such as ripe fruit, nuts and honey. They were harder to find, but when eating these foods we are rewarded with a hit of the feel-good neurotransmitter dopamine, encouraging us to find more. In modern society these foods are now easy to come by, and we have managed to intensify the feel-good rewards by creating recipes with added sugar and fat, massively magnifying the pleasure we get from eating.

Antigens determine your blood type

We still don't know why there are different blood types. There are 33 different blood-group systems in humans, but the most common are the A, B, O system, which has four types. Your red blood cells are coated in A antigens, B antigens, both A and B antigens, or neither (making you blood type O). We know these factors affect blood transfusion, but the reason behind different blood types seems to be related to the spread of infection; for example, people with blood type O are more susceptible to bubonic plague, but are better protected against malaria.

As wood burns, hydrocarbons evaporate into the air, either bursting into flame or floating up as smoke

Smoke occurs when there isn't enough oxygen

Wood is made from a combination of water, hydrocarbons, and minerals. As the temperature rises above 149 degrees Celsius (300 degrees Fahrenheit), the hydrocarbons start to vaporise, floating up into the air. They combine with oxygen, burning and releasing energy that is visible as a hot flame. As they burn, they release carbon dioxide and water vapour, both colourless gases that you cannot see.

Sometimes there is not enough oxygen for these evaporated components to burn, and instead, they continue to float upwards, rising in the hot air. The evaporated oils and tars clump together as they rise, forming fine particles known as smoke. The particles move about randomly, and as they collide with the invisible particles that make up the air, they change direction, producing the ever-changing swirling patterns of smoke.

After all of these volatile hydrocarbons have evaporated, all that is left is charcoal, nearly pure carbon. The charcoal does not evaporate, so as it burns there is no flame, just glowing embers. Once the charcoal is gone, all that remains is ash, the minerals like magnesium and potassium that do not burn at all.

DID YOU KNOW...

A lack of friction enables ice skaters to perform

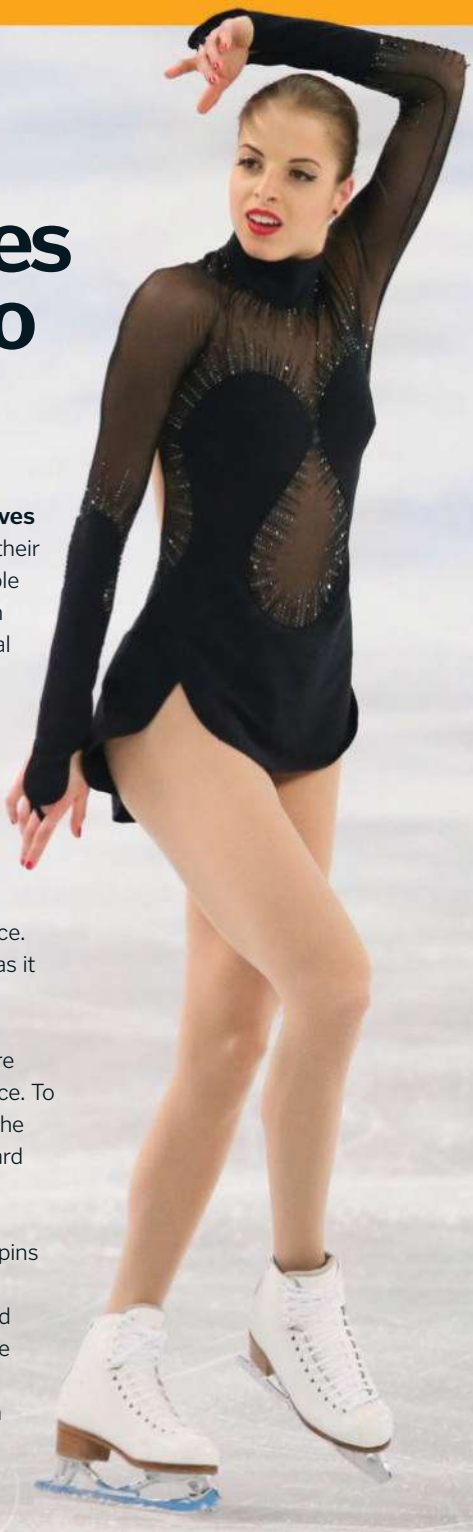


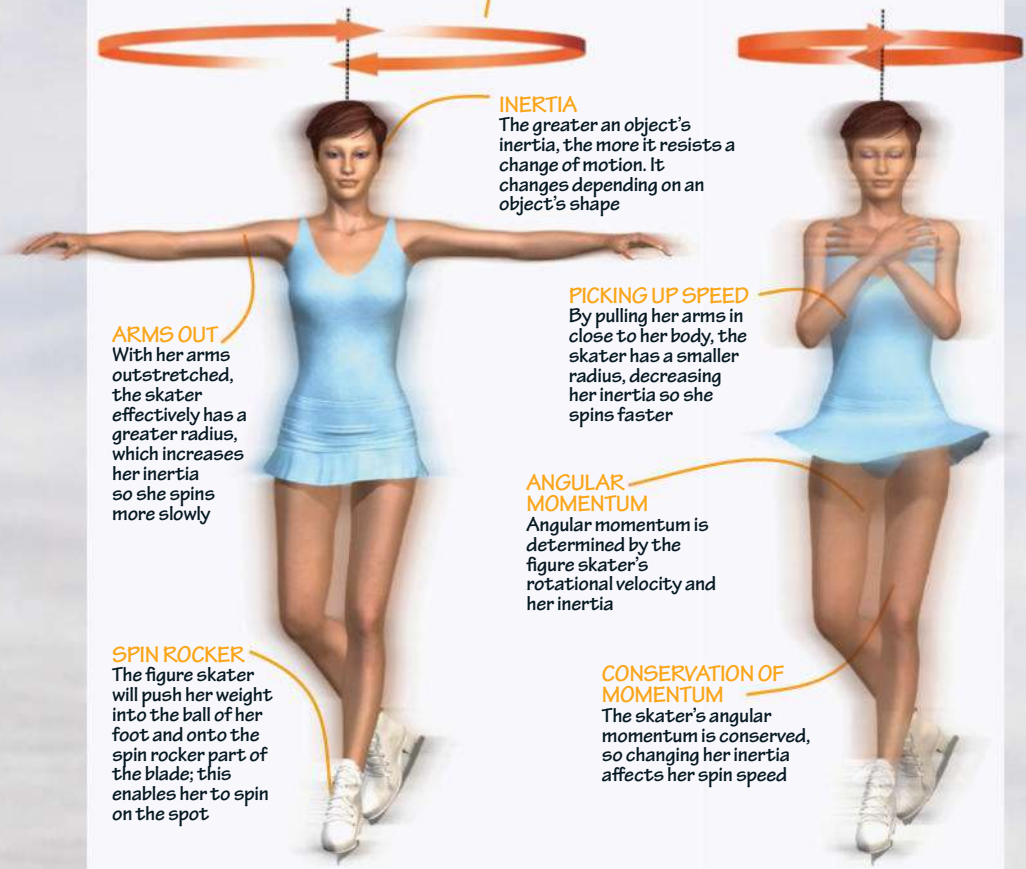
Figure skaters appear to glide effortlessly across the ice, performing breath-taking moves and spins, often at unimaginable speeds. At their core, these impressive performances rely on simple scientific principles, including friction, momentum and Newton's third law – every action has an equal and opposite reaction.

It's actually a lack of friction and the physical properties of the ice that enable a skater to glide, turn, speed up and stay in motion during a routine. Friction is a resisting force that occurs when two objects slide against one another, dissipating their energy of motion. A figure skater performing on smooth ice with sharpened skates will therefore encounter very little resistance. Some friction is still required for skating, though, as it enables skaters to start a stroke and come to a complete stop.

Newton's third law helps to explain how a figure skater is able to move and execute jumps on the ice. To put it simply, a skater will apply force down onto the surface of the ice; the ice then generates an upward force, which pushes back and helps to propel the skater into the air.

Figure skating routines that feature dramatic spins also rely on angular momentum. The amount of momentum depends on the skater's weight, speed and the distribution of mass from the centre of the body. Because of this, skaters will often tuck their arms in during a spin to reduce their radius, which in turn enables them to pick up more speed as they spin.

SCIENCE OF SPINNING



RADIUS
The skater's inertia is affected by her mass and her 'radius' – her limbs' distance from the central axis of rotation

INERTIA
The greater an object's inertia, the more it resists a change of motion. It changes depending on an object's shape

ARMS OUT
With her arms outstretched, the skater effectively has a greater radius, which increases her inertia so she spins more slowly

PICKING UP SPEED
By pulling her arms in close to her body, the skater has a smaller radius, decreasing her inertia so she spins faster

ANGULAR MOMENTUM
Angular momentum is determined by the figure skater's rotational velocity and her inertia

SPIN ROCKER
The figure skater will push her weight into the ball of her foot and onto the spin rocker part of the blade; this enables her to spin on the spot

CONSERVATION OF MOMENTUM
The skater's angular momentum is conserved, so changing her inertia affects her spin speed

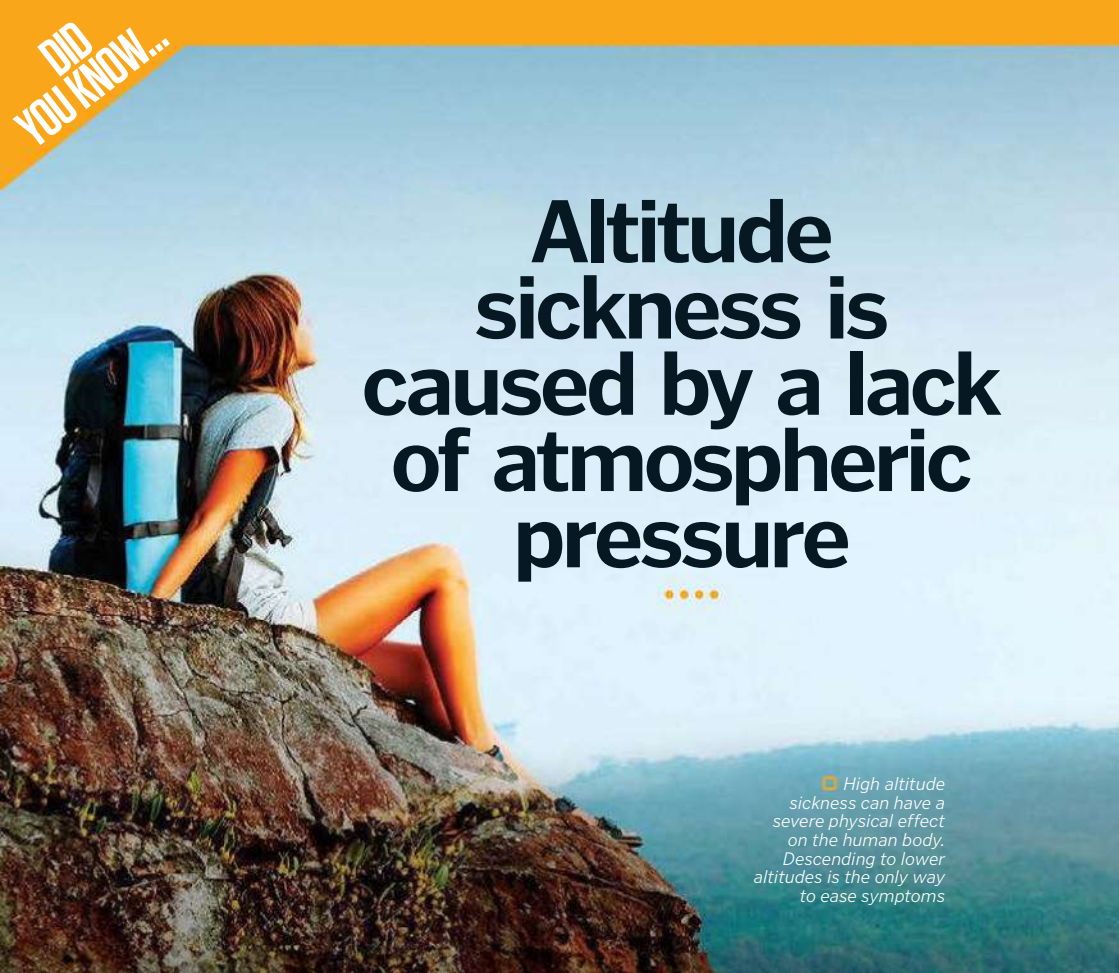
FIGURE SKATE DESIGN

Figure skates' unique design helps to ensure the athlete is able to glide and complete complex manoeuvres on the ice. The prominent metal blade, which is attached to the bottom of the boot, has a slight inward curve added when it is sharpened. This is known as the rock and offers two edges to skate upon, the inside and outside edge. Skaters will use the edges to move across the ice and pick up speed. It's also possible to skate on both edges, which is known as skating on flat.

The sweet spot, which is just below the ball of the foot, is known as the spin rocker and is the area on the blade that the skater will use to spin. The spikes at the tip are called toe picks and are used primarily for fancy footwork and jumping.

DID YOU KNOW...

Altitude sickness is caused by a lack of atmospheric pressure



High altitude sickness can have a severe physical effect on the human body. Descending to lower altitudes is the only way to ease symptoms

Adventurous explorers can spend months training prior to scaling mountain peaks, but regardless of fitness level, high altitudes can take a toll on the human body.

Between around 1,524 and 3,505 metres (5,000 and 11,500 feet) above sea level is considered high altitude. Most travellers will start to feel the effects of high altitude sickness as they attempt to acclimatise to the change in atmosphere at these heights. The most common symptom is shortness of breath, which is due to a lack of atmospheric pressure. At these heights, air molecules are more dispersed, so less oxygen can be inhaled. In order to compensate, your heart rate will increase and the body will produce more red blood cells, making it easier to transport oxygen around the body.

The low humidity levels at high altitude can also cause moisture in the skin and lungs to evaporate quicker, so dehydration is a real threat. Your face, legs and feet may start to swell as the body attempts to retain fluid by holding more water and sodium in the kidneys.

Difficulty sleeping is also common, and symptoms of high altitude sickness can get progressively worse the higher you climb, including mood changes, headaches, dizziness, nausea and loss of appetite.

A Nobel Prize was awarded for an explanation of hula-hooping

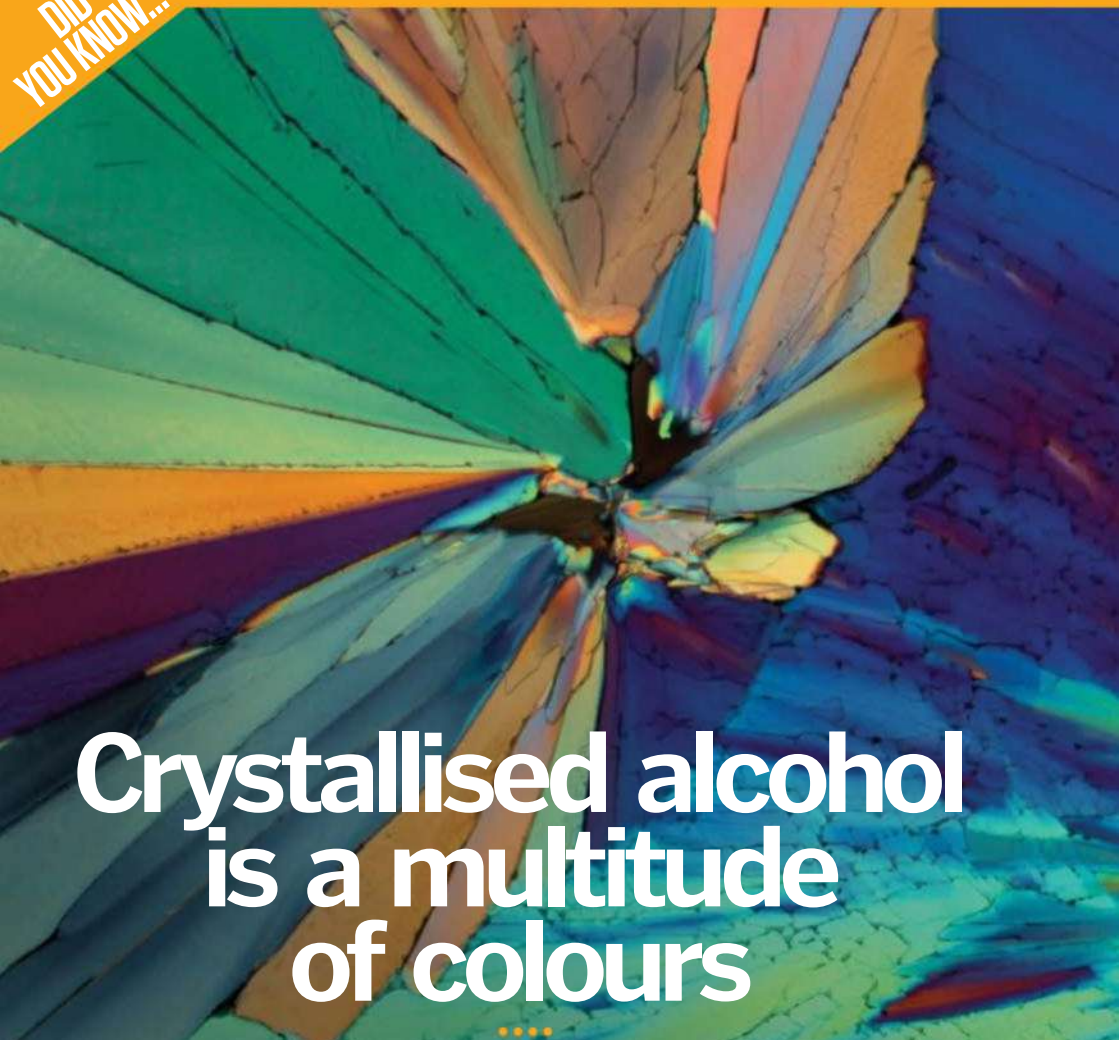
THE FORCES BEHIND HULA HOOPING

Although hula hooping comes relatively naturally to most of us, it's actually quite a complex task from a biomechanical viewpoint. In fact, the 2004 Ig Nobel Prize in Physics was awarded for an explanation of hula-hoop dynamics.

The hoop is able to spin due to the momentum created by pushing your hips and stomach back and forth, and by slightly shifting your weight as it spins. The reason the hoop keeps spinning is due to the forward motion of your hips, and not because of any circular movement, which is wrongly implied by the word 'hula' in its name.

This activity has recently gained in popularity due to its potential health benefits. It works the abdominal muscles in your core and studies have shown that using a weighted hoop may help to burn visceral fat, which can be detrimental to the heart.

DID YOU KNOW...



Crystallised alcohol is a multitude of colours

If you leave a drop of an alcoholic beverage, to dry out, the water and alcohol will eventually evaporate to leave behind crystallised sugar. If you then look at this sugar through a polarising microscope, you will see a pattern of bright colours as light refracts through the crystals.

The effect is created using two polarising filters, one between the crystals and the light underneath them, and another positioned at a 90-degree angle from it, between the crystals and the microscope lens above them. As these filters force light waves to oscillate in one direction, rather than all different directions as they would normally, the two polarising filters should block the light completely. But when the light passes through the crystals, it refracts, allowing it to pass through the filters at different angles so we see lots of vibrant colours. Geologists use the same technique to study the structure and composition of rocks.

Crytalised alcohol refracts the lights that hits it, causing a plethora of colours

DID YOU KNOW...

It is entirely possible for a singer to shatter glass

There must be microscopic defects big enough to allow the glass to buckle

All objects have a frequency at which it vibrates. Sound waves from the singer's voice vibrate air molecules surrounding the glass, causing the glass itself to vibrate. This is known as resonance. The glass would need to have microscopic defects big enough to buckle under the pressure for the glass to shatter, though. The chances of finding such a glass are slim, particularly as the fractures cannot be seen by the naked eye. Furthermore, the note the singer hits must match the glass's resonant frequency.

Mint makes water taste colder because of menthol

© Thinkstock

Cold-sensitive nerves are coated in tiny pores known as TRPM8 receptors, which are usually firmly closed. When the temperature drops, the channels open, and positively charged ions flood into the nerve cell triggering an electrical signal that travels towards the brain. Although mint does not actually reduce the temperature of the mouth, it contains an ingredient called menthol, which can stick to the TRPM8 receptors. This makes the receptors more sensitive than before, meaning that if you drink a glass of cold water the channels will open more easily, making it feel colder.

The secret to popping candy is in the recipe

Popping candy explodes on the tip of your tongue, creating a fizzing sensation in the back of your throat. The secret to its unique fizz, crackle and pop is actually all down to how it is made.

In fact, popping candy is created in a similar way to traditional boiled sweets. Sugar, corn syrup, water and flavouring are all mixed together and then heated so that the water boils off. If the resulting sugar syrup solution would be left to cool at this stage, you'd end up with regular hard sweets. But in order to give the candy its unique popping potential, the molten mixture is exposed to high-pressure carbon dioxide gas at about 40 times atmospheric pressure. This causes small bubbles of gas to form within the solution. As this is then cooled, the pressure is released, causing the candy to shatter into small pieces of rock. However, each piece still contains tiny high-pressure bubbles. When you then place the candy on the tip of your tongue, and it begins to melt, the trapped pressurised bubbles are released, creating a unique sizzling sound and the sensation of it bursting and bouncing around your mouth.

Pop Rocks candy bounces in your mouth when high-pressure carbon dioxide bubbles are released as it melts on your tongue

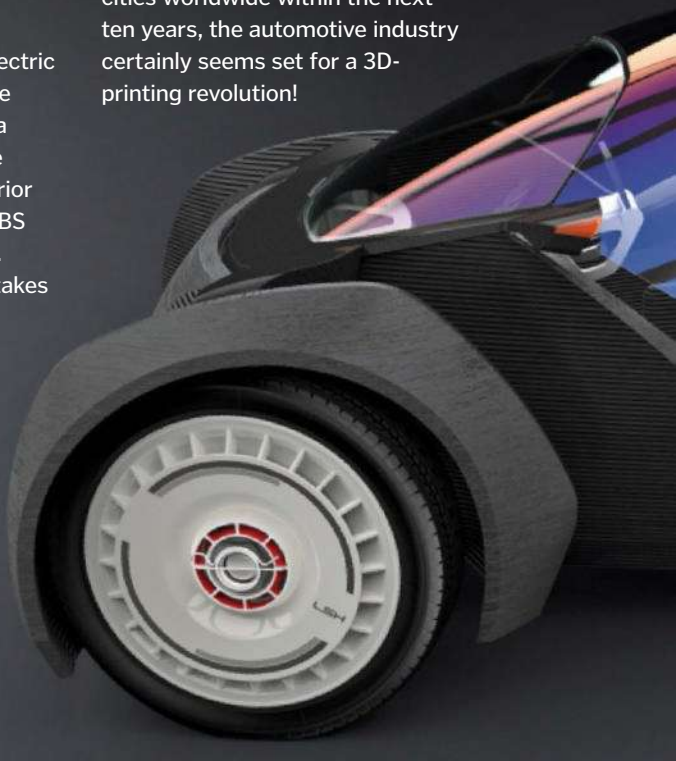
DID YOU KNOW...

It's possible to 3D print a car

Being able to buy your own 3D-printed car from a factory nearby may soon become a reality with the Strati from Local Motors. Created using BAAM (big-area additive manufacturing), the world's first fully drivable 3D-printed car will be electric and have just 40 parts – significantly fewer than the 2,000 parts most vehicles include. Mechanical components such as the battery, motors, wiring and suspension are sourced from Renault's Twizy, an electric city car, while everything else on the Strati that could be integrated into a single material piece – including the frame, exterior body and some interior features – has been printed using ABS plastic reinforced with carbon fibre.

The two-seater design currently takes 44 hours to print, and Local Motors aims to be able to speed the process up to 24 hours without any reduction in build quality. The Strati's body is made up of approximately 212 layers laid down slice by slice; making the Italian word for layers, 'strati', an ideal name. Driving the car is an electric motor powered by a 6.1-kilowatt battery that can be recharged in a comparatively fast three-and-a-half hours and propel the Strati up to a top speed of about 80 kilometres (50 miles) per hour.

Local Motors is developing the car as an open-source project, allowing all digital 3D-print files and build manuals to be freely downloaded and even modified by individual users. With the company also intending to open 100 microfactories near major cities worldwide within the next ten years, the automotive industry certainly seems set for a 3D-printing revolution!



WHAT IS BIG-AREA ADDITIVE MANUFACTURING?

Similar to the process used by at-home desktop 3D printers, BAAM relies on a digital 3D model part becoming sliced into layers, which are then used to generate the real layers of ABS plastic that are created by the 3D printer when laying down the material slice by slice. Aside from the print size required, one of the major differences between a desktop 3D printer and the system used to create the Strati is the feed system.

The Local Motors team use a pellet feed as opposed to filament-fed extruders as feedstock is significantly cheaper than filament, making it easier to experiment with more material combinations.

This is a huge help with elements such as the durable carbon-fibre composite ABS used to print the Strati's components.

Carbon-fibre composite ABS may be difficult to find in filament form, but there are many new metallic filaments you can buy for use with a 3D printer

> "Xen-source project, allowing all digital 3D-print files and build manuals to be freely do"

The 3D-printed Strati will reportedly go on sale in 2016, with cost likely to be in the range of £11,800-£19,700 ($18,000-$30,000)

DID YOU KNOW...

Riding the Wall of Death requires a good understanding of physics and a lot of bravery

Motorcyclists can defy gravity on the Wall of Death

The Wall of Death – also known as the motordrome or silodrome – is a barrel-shaped cylinder, usually made out of wood. Motorcyclists perform stunts while riding on the vertical wall.

The Wall of Death is a popular travelling carnival act dating from the early-20th century, but there are just a few left today. The motorcyclist starts at the bottom with the crowd looking down into the drum. After ascending a ramp to gain speed, they then begin circling the vertical wall, held in place by centripetal force. There are three forces working on the cyclist: gravity, the wall and friction. The cyclist must maintain a constant speed to keep the motorcycle's direction of motion constantly changing. They must also lean up at an angle (with respect to the wall) while riding to keep the bike's torque at zero.

This impressive feat occasionally results in accidents if the cyclist gets too close to the top of the wall or fails to maintain the speed or angle necessary to stay up.

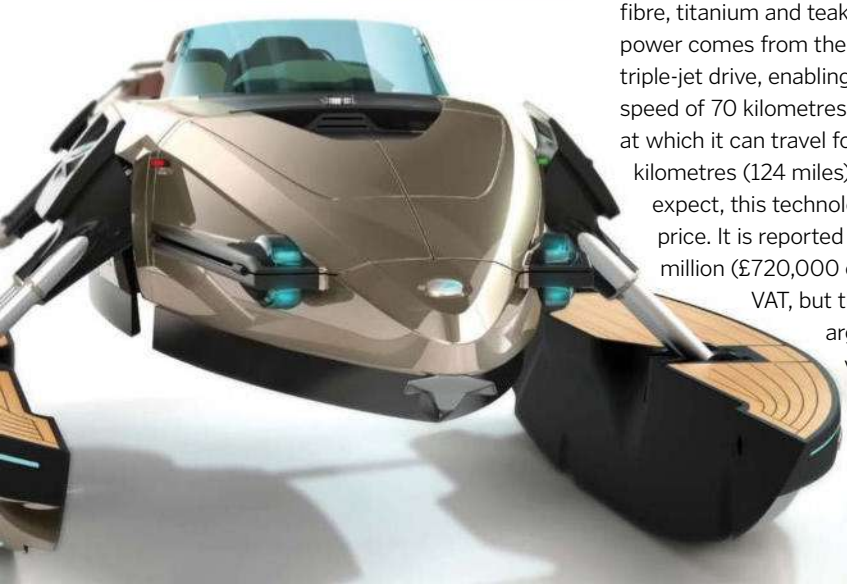
One of the six formations is a three-hull 'trimaran'

One configuration transforms the Kormaran into a diving and sunbathing platform

The shape-shifting boat has six shapes

The Kormaran is set to make waves – both figurative and literal – in the boating industry. By operating the hydraulic arms electronically, the driver is able to change the Kormaran into six configurations, including a three-hull 'trimaran'. This works by moving the outer hulls by differing amounts, altering the number of hulls in contact with the water. A hydrofoil formation is also possible, which results in extremely efficient travel thanks to an 80 per cent reduction in water resistance due to the hull not touching the water.

Measuring 6.4 metres (21 feet) long, it is built using quality materials such as carbon fibre, titanium and teak. The Kormaran's power comes from the 493-horsepower triple-jet drive, enabling it to reach a top speed of 70 kilometres (43 miles) per hour, at which it can travel for up to 200 kilometres (124 miles). As you would expect, this technology comes at a price. It is reported to cost around €1 million (£720,000 or $1,070,000) plus VAT, but the company will argue this is good value for money, as you effectively get six boats for the price of one!



DID YOU KNOW...

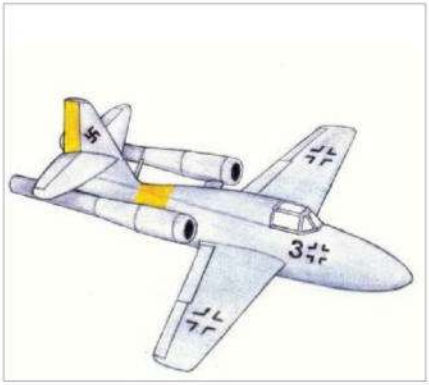
The AirBoard can get 1.5m off the ground

Ever wanted to fly but don't have the time or money to train as a pilot? The new AirBoard could be the answer. The smallest one-person aircraft in the world, it can carry the weight of a single person using its powerful battery. The AirBoard is classified as an ultralight quadcopter aircraft and it's small enough to fit in the boot of your car.

Its thrust is provided by four high-speed electric motors that each power a propeller. The drive system is managed by an Intel processor chip that incorporates a ground collision sensor to keep the board at a set height above the ground. This system comes into its own when you take the AirBoard into the great outdoors. Designed for both urban and rural use, the quadcopter will hover over nearly all ground, whether it's a snowy plain, water, rocky terrain or just in the street.

The device is easy to control, requiring the user to merely lean in the direction they want to go. For safety, the board's altitude is limited to a tame 1.5 metres (4.9 feet). The AirBoard's qualities make it ideal for recreational use but its features also make it potentially useful in search and rescue for the emergency services and perhaps even espionage for the military.

THE CONTENDERS



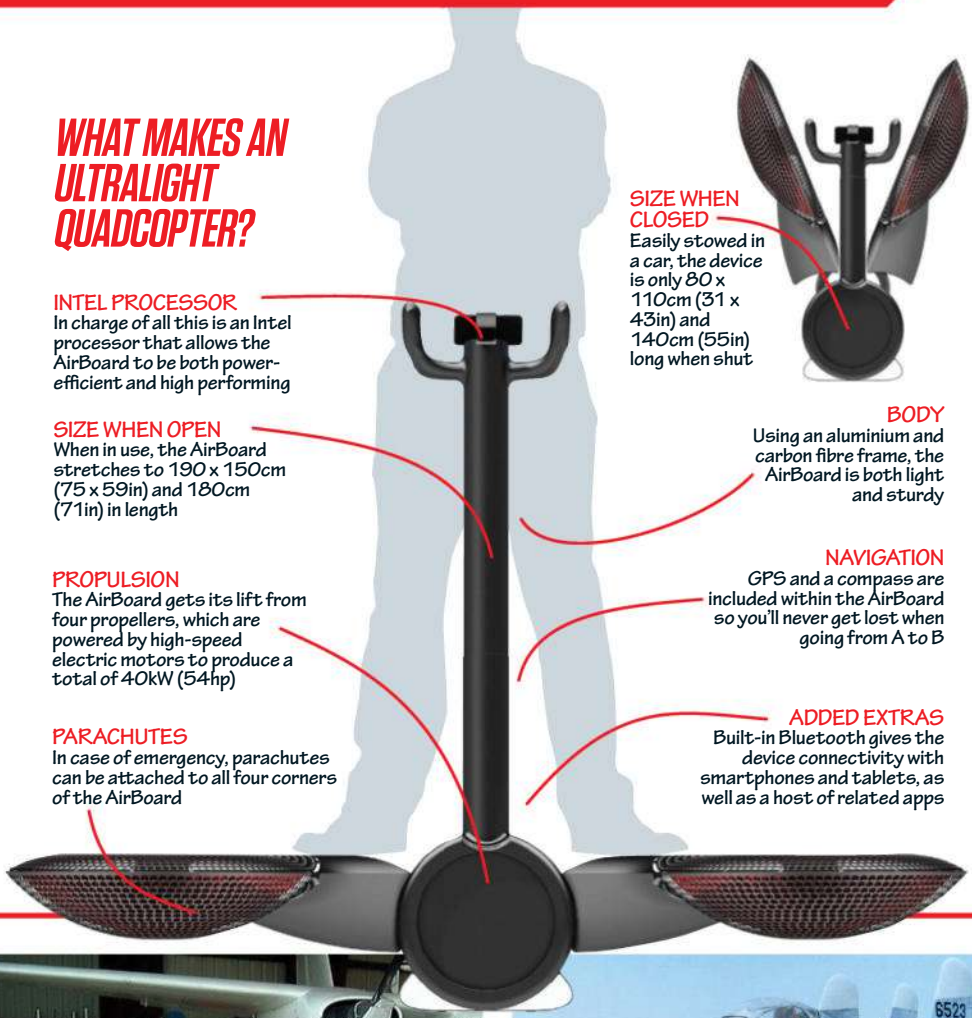
MESSERSCHMITT ME-328

It may have never made it past the prototype stage, but the Messerschmitt Me-328 is the smallest pulsejet fighter of all time. It would have been used by Nazi Germany as a parasite fighter launched off larger aircraft.

BUMBLE BEE II

The tiny 2.7m (8.8ft)-long Bumble Bee II, built by Robert H Starr, is listed by the Guinness Book Of Records as the smallest aircraft ever made. It took its first flight on 8 May 1988, but crashed due to engine failure on the same day.

WHAT MAKES AN ULTRALIGHT QUADCOPTER?



INTEL PROCESSOR
In charge of all this is an Intel processor that allows the AirBoard to be both power-efficient and high performing

SIZE WHEN OPEN
When in use, the AirBoard stretches to 190 x 150cm (75 x 59in) and 180cm (71in) in length

PROPULSION
The AirBoard gets its lift from four propellers, which are powered by high-speed electric motors to produce a total of 40kW (54hp)

PARACHUTES
In case of emergency, parachutes can be attached to all four corners of the AirBoard

SIZE WHEN CLOSED
Easily stowed in a car, the device is only 80 x 110cm (31 x 43in) and 140cm (55in) long when shut

BODY
Using an aluminium and carbon fibre frame, the AirBoard is both light and sturdy

NAVIGATION
GPS and a compass are included within the AirBoard so you'll never get lost when going from A to B

ADDED EXTRAS
Built-in Bluetooth gives the device connectivity with smartphones and tablets, as well as a host of related apps

BEDE BD-5

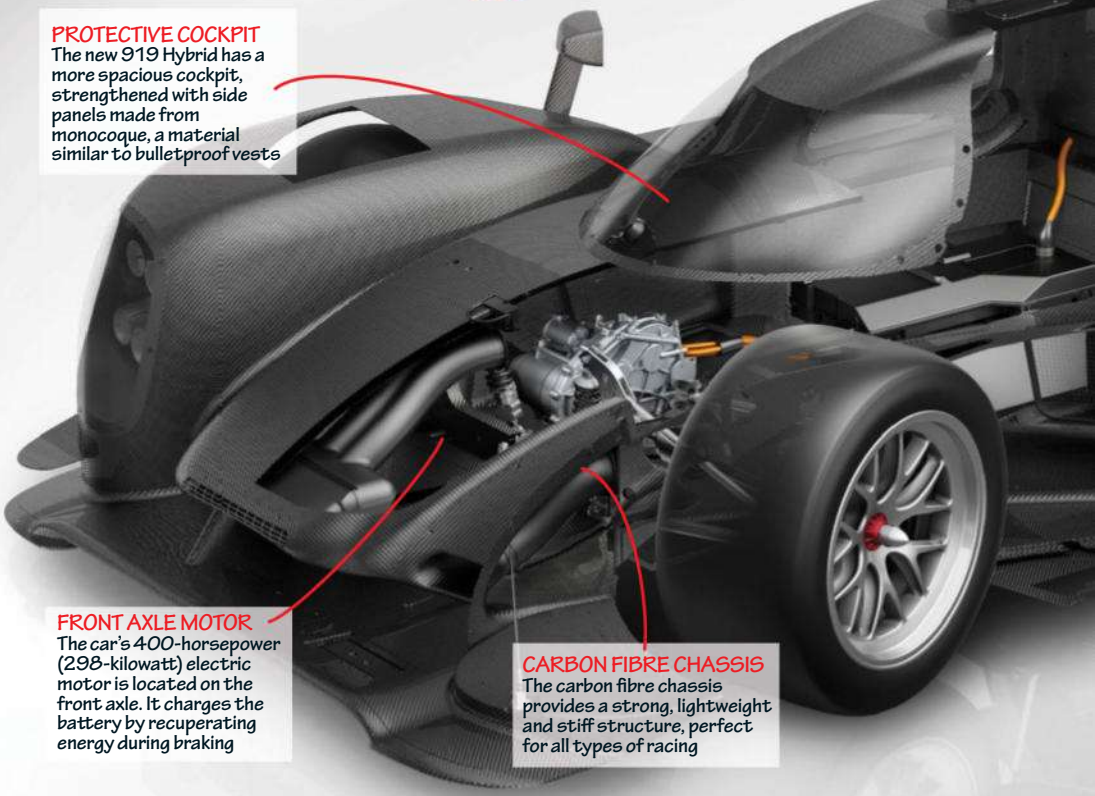
The Bede BD-5 is considered the smallest civilian jet but not the world's smallest aircraft. Its first flight was in 1971 and despite its 3.8m (12.5ft) length it can reach a top speed of 483km/h (300mph).

XF-85

A prototype parasite fighter like the Me-328, the American XF-85 Goblin was the world's smallest jet fighter. At 2,050kg (4,519lb) when loaded, it is significantly heavier than the civilian aircraft on the list, mainly due to its four machine guns.

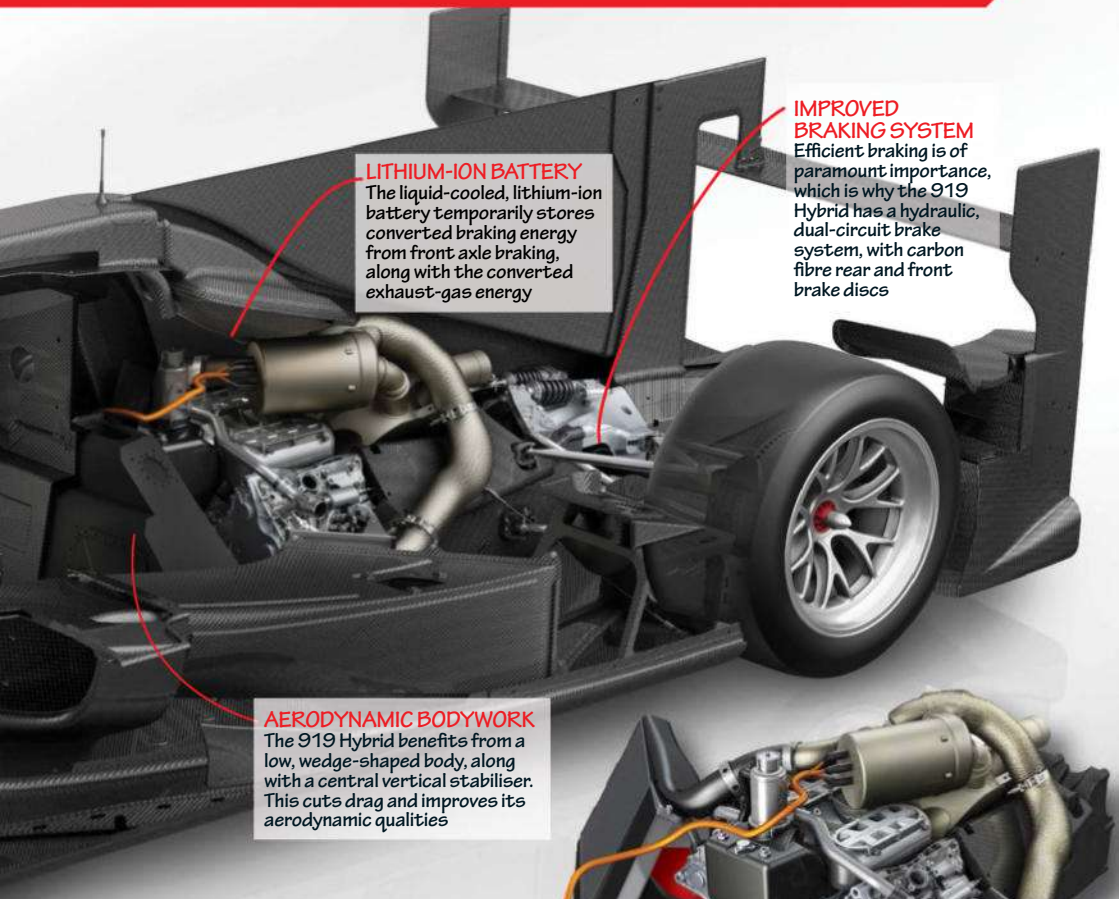
DID YOU KNOW...

The Porsche 919 Hybrid produces 500 horsepower



The 24 Hours of Le Mans is the oldest active endurance race in the world. It has been held every year since the inaugural race in 1923 and is often referred to as the 'Grand Prix of Endurance and Efficiency'. Keeping a car running for 24 hours is no mean feat; excellent fuel, tyre and braking efficiency is a must if you want to stay out of the pit lane. The race is also very demanding for the drivers. They form part of a team of three, often driving for two hours at a time, which challenges them both physically and mentally. During the 24 hours, the competitors will typically cover distances of over 5,000 kilometres (3,107 miles). The record distance of 5,410.71 kilometres (3,362.06 miles) was set in 2010, which is the equivalent of completing a Formula One race 18 times.

Porsche is the most successful manufacturer in the history of Le Mans. It's been the overall winner 17 times, however Audi, who has won 13 of the last 16 Le Mans, claims recent dominance of the test.



LITHIUM-ION BATTERY
The liquid-cooled, lithium-ion battery temporarily stores converted braking energy from front axle braking, along with the converted exhaust-gas energy

IMPROVED BRAKING SYSTEM
Efficient braking is of paramount importance, which is why the 919 Hybrid has a hydraulic, dual-circuit brake system, with carbon fibre rear and front brake discs

AERODYNAMIC BODYWORK
The 919 Hybrid benefits from a low, wedge-shaped body, along with a central vertical stabiliser. This cuts drag and improves its aerodynamic qualities

Porsche hadn't claimed the title since 1998, but rediscovered its winning formula in the redesigned 919 Hybrid. The 2015 Porsche 919 Hybrid was thoroughly tested, clocking an impressive 26,675 kilometres (16,575 miles) on four different race tracks. It features a vastly improved engine system; the electric motor's performance has been increased by a third, meaning the 919 Hybrid raced in the eight-megajoule category for the first time this year. Having become lighter, more robust and easier to handle, the designers managed to lead Porsche to their 17th Le Mans title, with Formula One's Nico Hülkenburg and Porsche factory driver Earl Bamber at the helm in their first ever Le Mans endurance test.

THE V4 PETROL ENGINE

At the heart of the 919 Hybrid is a turbocharged, gasoline-powered engine that sends power straight through to the car's rear wheels. It contains four cylinders, which work together to produce 500 horsepower (373 kilowatts) and revs at 9,000rpm – this is pretty impressive for a two litre engine. Also located here is the car's gearbox, along with a generator spun by the turbocharger. The engine is mainly made of aluminium, with magnesium and titanium incorporated within it, achieving an ideal weight for the car. Combined with the 919 Hybrid's two energy recuperation systems, it means that altogether the V4 makes for a very efficient race-car engine.

DID YOU KNOW...

Electric cars can be charged by the sun

Electric and hybrid cars are becoming much more of a common sight on the roads, with many plug-in charging stations now visible in car parks and service stations around the globe. However, there's a new technology now available that enables these cars to be charged without the need for a mains power supply, instead drawing on energy from the Sun.

This system of solar panel parking works by converting daylight energy into electric energy, trickle-charging cars ready for use. Photovoltaic panels mounted to the roof of the parking lot or carport absorb the Sun's rays and convert the solar energy into electric energy compatible with the automobile, which is fed in via an adaptor to the car's standard electric charging port.

However, while this can reduce costs of electricity charging at the mains, photovoltaic panels are not yet efficient enough to convert all the solar energy they receive into electricity, so several hours of solar charge won't power a car for a long period of time. The technology is in its infancy, though, and could well provide a framework for the future of regenerative-fuelled motoring.

This solar panel parking unit was installed at a parking lot in Portland, USA, in 2011 for electric cars to use

Jet skis work in accordance to Newton's third law

You probably know these high-powered machines as Jet Skis, but that's just a brand name. The real term is a personal watercraft (PWC) and they can hit speeds of over 100 kilometres (62 miles) per hour and churn out around 220 kilowatts (300 horsepower) of power as they zoom across the water.

Since a PWC weighs as much as five adults, the engine has to be really powerful. The engine tasked with reaching these speeds uses Newton's third law of motion, which states that for every action there is an equal and opposite reaction. A PWC works by sucking water through a grate at the bottom of the craft and shooting it out the back. This force pushing backward from the engine propels the craft forward. It's similar to when you're swimming front crawl, pulling back with your arms in order to keep moving. Rocket engines actually work based on the same principle, using hot gas instead of water.

DID YOU KNOW...

Solar Impulse 2 can take flight without fuel

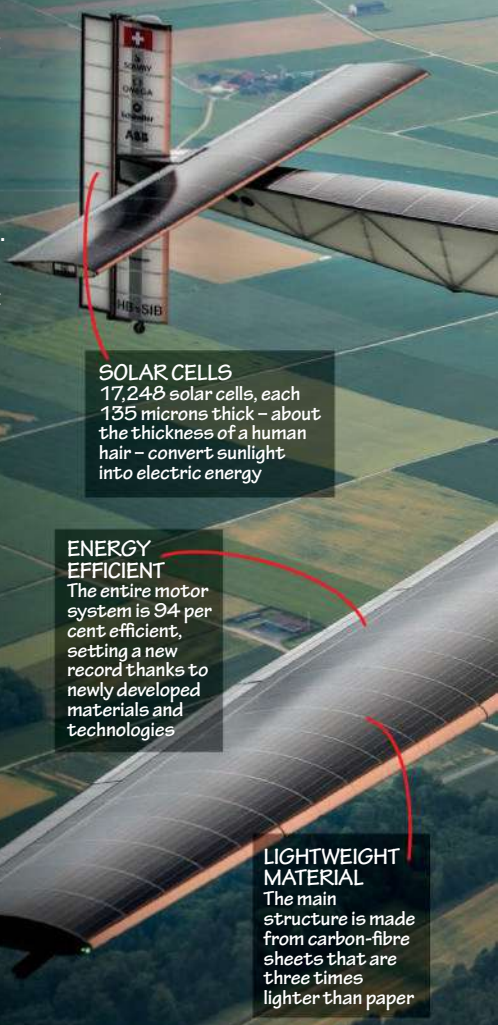
On 9 March 2015, the first-ever round-the-world flight powered only by solar energy took off. The Solar Impulse 2 started its mammoth journey in Abu Dhabi, with the aim of flying over oceans and continents before landing back where it started in a series of 12 legs, the longest at five days over the Atlantic and Pacific oceans. The whole flight was expected to take around 500 hours or just over 20 days, paced over 5 months.

Unfortunately, the flight over the Pacific caused irreparable damage to the batteries by over-heating. New batteries means more testing will have to be carried out before it can continue on its flight and it is due to start again in April 2016. It does however hold multiple World Records, one for the longest solar flight for both time and distance, and one for the longest solo flight by time – it was this leg that damaged the batteries.

Despite its unlimited energy supply, it is the pilot's need for rest and a limited space for food supplies that enforces stops. Taking turns at the controls will be Solar Impulse chairman Bertrand Piccard and cofounder and CEO André Borschberg.

It works by turning sunlight into electric energy using the solar cells stretched across its enormous 72-metre (236-foot) wingspan. The whole aircraft weighs only 2,300 kilograms (5,071 pounds) helping it climb to a maximum altitude of 8,500 metres (27,890 feet). At night it will drop to 1,500 metres (4,920 feet) to conserve as much of the energy stored in the four batteries as possible. To avoid turbulence and winds of more than seven knots (13 kilometres [eight miles] per hour), all takeoffs and landings will be scheduled at night.

POWERING THE SOLAR IMPULSE 2



SOLAR CELLS
17,248 solar cells, each 135 microns thick – about the thickness of a human hair – convert sunlight into electric energy

ENERGY EFFICIENT
The entire motor system is 94 per cent efficient, setting a new record thanks to newly developed materials and technologies

LIGHTWEIGHT MATERIAL
The main structure is made from carbon-fibre sheets that are three times lighter than paper

72-HOUR FLIGHT SIMULATION

Both pilots have completed 72-hour stints in a flight simulator, recreating the cockpit conditions. This enabled them to test and evaluate their nutrition plan, toilet facilities and exercise regime to prevent deep vein thrombosis. They could also try out their rest strategy, which uses relaxation techniques for the shorter flights and taking 15 to 20-minute micro-naps for the longer stretches.

STORING ENERGY
The batteries can store 260Wh/kg and can be fully charged in just 3-4 hours when the aircraft is grounded

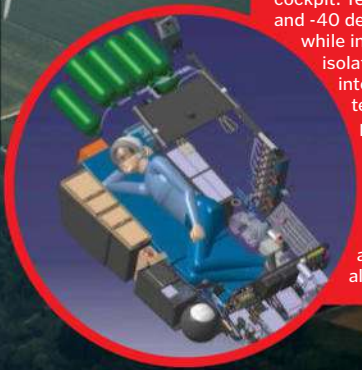
MAXIMUM SPEED
The aircraft has maximum power of 70hp (52.2kW) and can reach speeds of up to 140km/h (87mph) at maximum altitude

CREATING THRUST
The four motors each generate 17.5hp (13kW) of power, rotating the 4m (13.1ft)-diameter propellers to create thrust

BATTERY POWERED
Energy is stored in four lithium polymer batteries, which weigh 633kg (1,396lb) – over a quarter of the aircraft's total weight

INSIDE THE COCKPIT

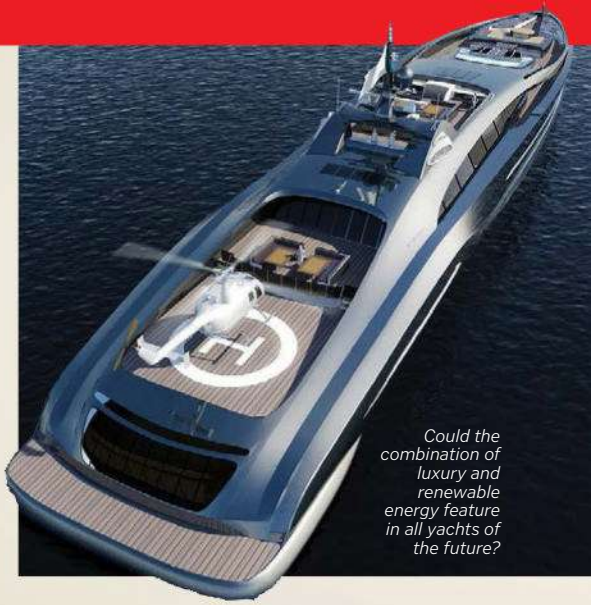
The 3.8-square-metre (40.9-square-foot) cockpit will be each pilot's home for up to five days at a time. It can store the 2.4 kilograms (5.3 pounds) of food, 2.5 litres (0.7 gallons) of water and one litre (0.3 gallons) of sports drinks they will need each day, plus enough oxygen to survive in the unpressurised cockpit. Temperatures will fluctuate between +40 and -40 degrees Celsius (-40 degrees Fahrenheit) while in the air, so the cockpit is insulated with isolation foam, and the pilot's clothing contains intelligent nylon fibres to stabilise their body temperature. The seat contains the toilet, parachute and life raft, plus it can lie flat to allow the pilot to stretch their legs. A matchbox-sized electrocardiogram will monitor the pilot's fatigue and vigilance and a tailor-made autopilot system will monitor the aeroplane. They will also have a vibration device fitted into their sleeves to alert them to any problems or anomalies.



This illustration shows the pilot's resting position in the Solar Impulse 2's cockpit

DID YOU KNOW...

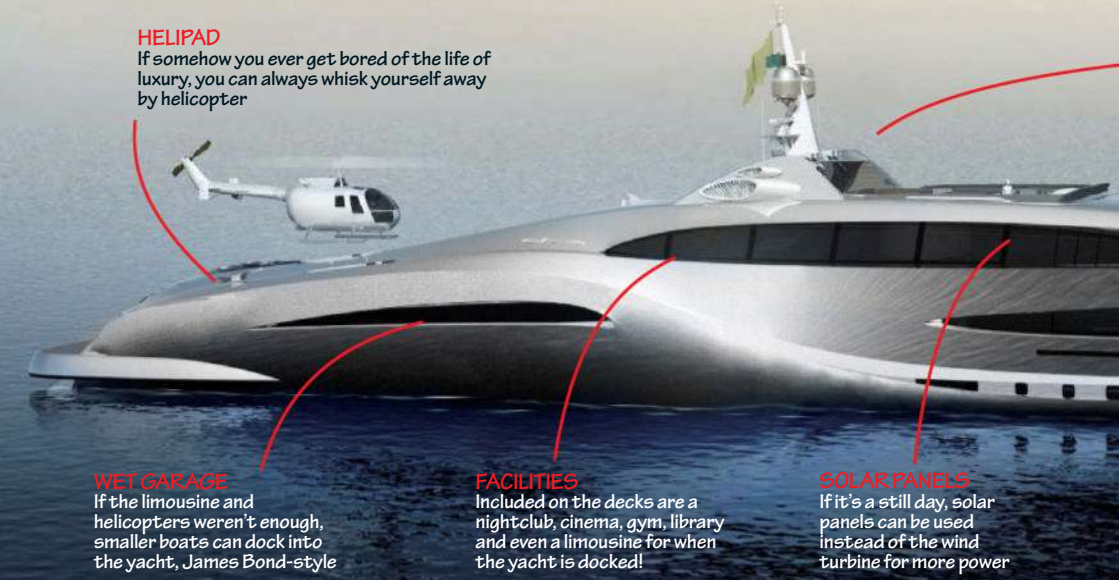
There is a helipad on the Sovereign Yacht



Could the combination of luxury and renewable energy feature in all yachts of the future?

100 metres (328 feet) of luxury craftsmanship, the Sovereign superyacht could be one of the classiest vessels ever to take to the seas. So classy in fact, it has been conceived with international royalty in mind. The yacht was designed in 2011 by Gray Design and will open its doors to kings, queens and monarchs for cross-ocean travel. An excellent idea, but what about the execution?

The Sovereign gets top marks from the environment with its three MTU engines backed up by a readily available supply of wind and solar energy. This renewable system also powers the electronics on



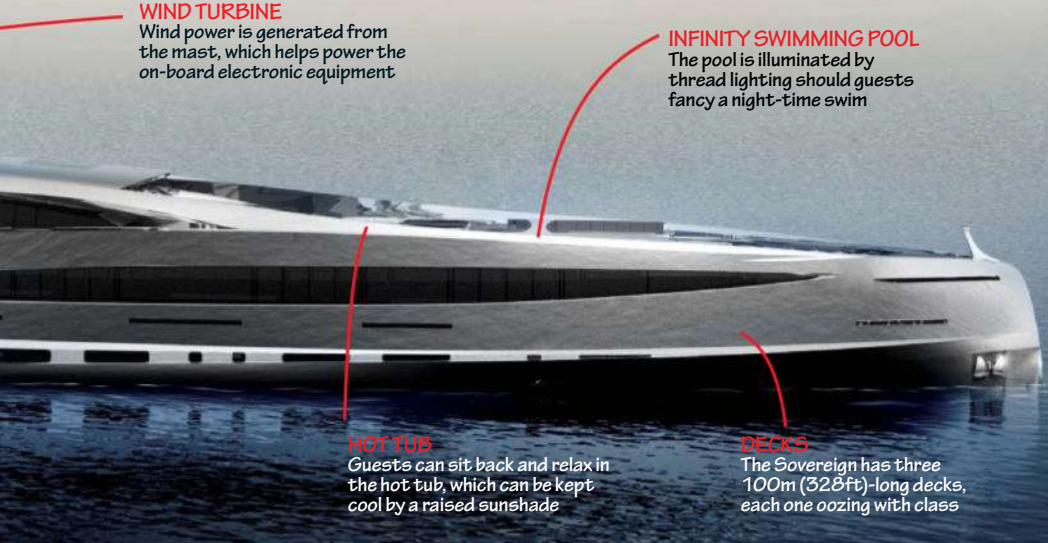
THE ROYAL YACHT BRITANNIA

For all its grandeur, the Sovereign is merely a pretender to the throne of luxury yachts. Serving the queen and the British royal family for almost 44 years, the Royal Yacht Britannia is the most recent of the royal yachts. Providing space for up to 250 guests, the royal family were catered for by 271 royal yachtsmen who communicated with a series of hand signals as shouted orders were banned.

The vessel made a mammoth 696 overseas visits in its operational lifetime. It is powered by two geared steam turbines and its facilities allow it to double up as a hospital ship if required. It is designed with modern tastes in mind with a clipper bow and modified cruiser stern alongside a cinema capable of showing 3D films. Such a luxurious vessel didn't come cheap, and in 1997 the Britannia was decommissioned due to its high running costs.

board and could potentially act as a template for greener solutions in the future. The rest of the Sovereign's features are quite simply jaw-dropping. From a reinforced glass helicopter pad, to both a wet and dry garage complete with limousine and speedboat, this yacht is the definition of luxury.

Sunburn will also be a thing of the past with a retractable cover over the pool area on the bow. This all makes the two illuminated swimming pools pale in comparison! There are ten guest suites on the yacht so even an extended royal family could happily spend weeks away from dry land.



DID YOU KNOW...

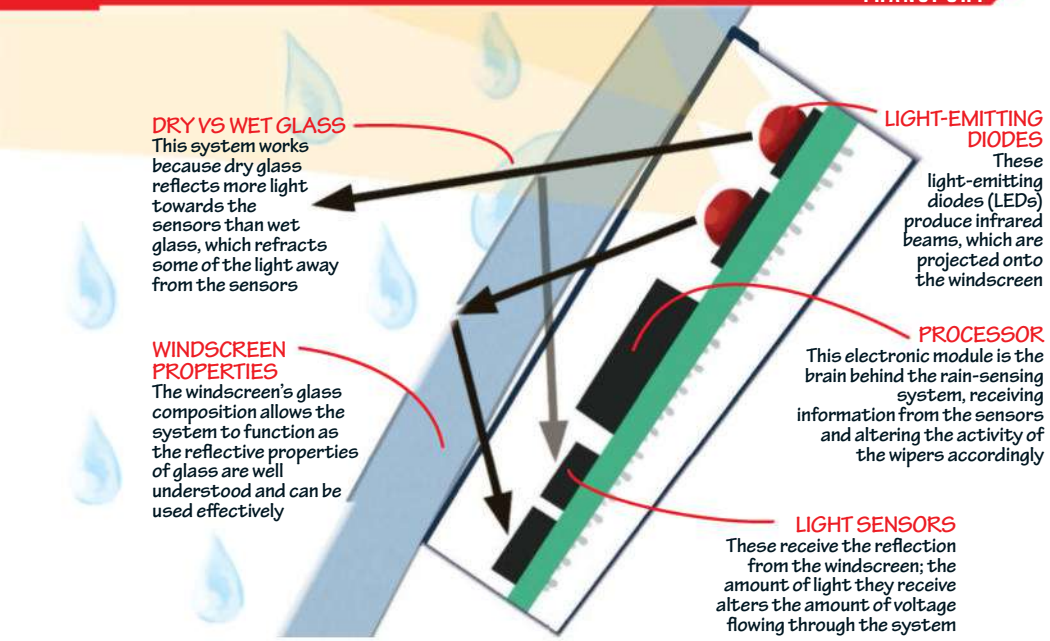
The Air Wheel can travel up to 45km without being charged

The AirWheel is priced between £509.99 and £799 ($849 and $1,333) and comes in six different unicycle models

The brand new AirWheel – a self-balancing unicycle – could really liven up your daily commute. By simply leaning in the desired direction, you will be transported to wherever you want to go with the minimum of fuss. The AirWheel incorporates a fast-charging battery, like the ones used in the latest eco-friendly cars, and cutting-edge gyro technology that helps maintain its self-standing orientation.

On the most advanced model, a single charge will last for up to 45 kilometres (28 miles) and when the battery is spent it will gently lean back rather than cutting out sharply. Better still, when you go downhill or slow down, the battery will start to regenerate some of its lost juice.

Waterproof and made of a comfortable elastic silicone, the AirWheel has been ideally designed whether it's for your nine-to-five or a quick jaunt down the shops. Even stairs don't faze the device, with a built-in carry handle that can be safely stowed away when not in use.



In the future cars will have force fields

The intermittent windscreen wiper system has undergone much refinement since its first appearance in a 1970 Citroën SM. Although it may seem simple to flick a switch and turn on your wipers manually, automatic wipers have the advantage of reducing distraction and improving visibility. A popular automatic system uses invisible infrared light which is projected across the windscreen and reflected back toward an array of sensors. When rain hits the windscreen, the water droplets refract the light so less of it bounces back toward the sensors. The sensor, typically located on the back of your rearview mirror, detects these changes in the amount of light received. Software will then determine the required wiper speed depending on how much light is refracted by the water.

McLaren has reportedly been developing technology that will consign the windscreen wiper to history. By using ultrasound, its device effectively creates a force field over the windscreen, stopping water from staying on the glass. Whether this will be as efficient as full-speed wipers during a heavy downpour is yet to be seen.

The humble windscreen wiper has some clever technology powering it

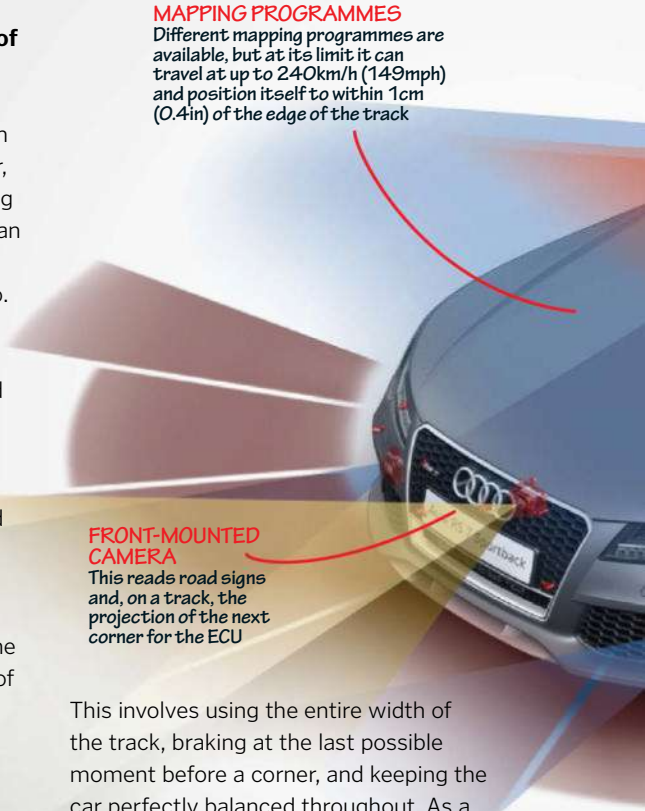
DID YOU KNOW...

An Audi RS7 can go faster without a driver

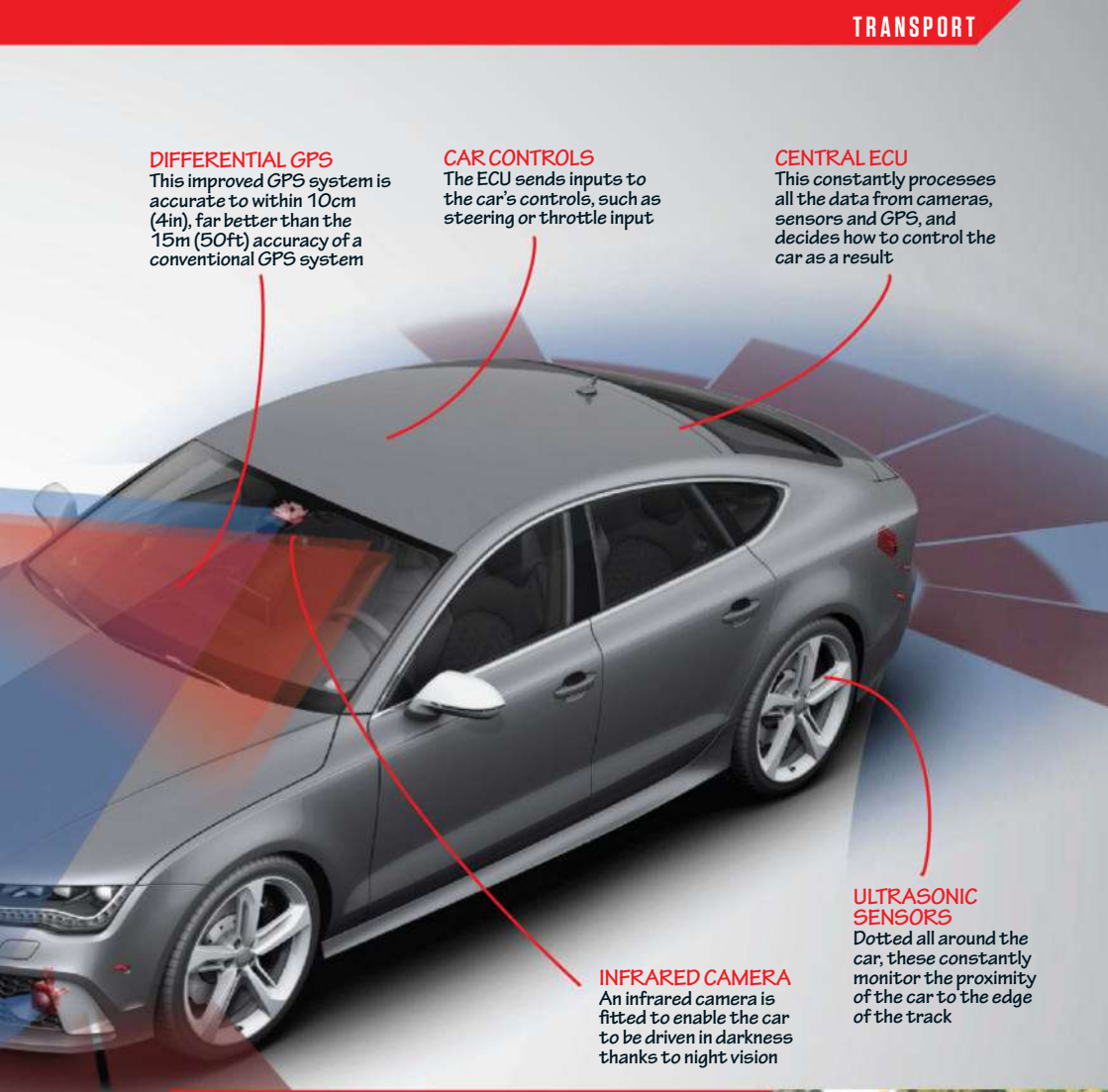
It's the age-old debate: is technology better than the talents of humans? In the automotive world, this argument is fast rearing to a head, with driverless cars now being fully tested on public roads around the world. However, while driverless cars are primarily aiming to be safer than those piloted by a human being, German manufacturer Audi wanted to find out if they are faster, too. The answer to this is the Audi RS7 driverless car prototype, a pumped-up sports car that's been specially adapted with driverless technology.

The RS7 driverless concept works in much the same way as a conventional driverless car currently being developed by other manufacturers, including Toyota and Google. As well as an advanced GPS system with pinpoint accuracy, cameras are placed around the vehicle that 'read' signs and the layout of the road or track ahead. These work in tandem with sensors and radars dotted around the vehicle, which constantly monitor the proximity of the car to the road and other objects. All this information is fed to a central computer, which processes the information and operates the car accordingly.

Where the Audi RS7 triumphs over other driverless cars, though, is not only in the speediness of this entire process, but also in its intelligence. On a track, a 'racing line' is taken by drivers to get around the track in the quickest time.



This involves using the entire width of the track, braking at the last possible moment before a corner, and keeping the car perfectly balanced throughout. As a thrash around the Hockenheim circuit demonstrated, the driverless RS7 prototype was found to take a very precise racing line on the track, nearly identical to that of a seasoned racing driver. The technology isn't without merit, either: a driverless RS7 actually beat a lap time around the Ascari circuit (by two whole seconds!) set by a human being in an identical car.



THE EVOLUTION OF THE DRIVERLESS CAR

The driverless car industry is fast evolving within the automotive industry. Interestingly, it's not car manufacturers themselves that are at the forefront of the technology either: that accolade goes to technology giant Google, which has developed a unique pod-like vehicle. Materials used on the Google car are also ground-breaking, with a bendy facia and plastic windscreen implemented to help cushion the blow to a human in the unlikely event of a collision.

Other companies such as Toyota or Volvo have been busy adapting their own conventional passenger vehicles to accommodate driverless tech, but the roof-mounted radar and bigger computers have often proved unsightly and impractical. But there's more: rumours are also gathering pace that Apple is developing its own autonomous vehicle, so watch this space...

DID YOU KNOW...

Smart helmets can predict accidents

Cyclists have long worn helmets to protect their head in the event of a collision. Now though, Swedish automotive manufacturer Volvo has created a pioneering new smart helmet that not only protects the cyclist, but also warns them of potential accidents. The helmet is part of a two-way system where both cyclists and drivers continuously upload their location to a cloud system. The system can then warn the respective parties as to the proximity or direction of oncoming objects that interferes with their own location and trajectory.

For cars, these warnings are conveyed via warning lights on a heads-up display system in front of the driver on their windshield, which is particularly useful for when a cyclist is in a vehicle's blind spot. For cyclists, these warning lights are built into an otherwise ordinary-looking helmet, which pulse from its beak. This ensures the cyclist is alerted to the impeding danger with enough time to take evasive action, without the lights impairing the vision of the cyclist.

While this is a great idea in principle, there are limitations to this early stage of technology. First, not everybody drives a Volvo, and second, many people will feel uncomfortable uploading their current location to a cloud sharing service.

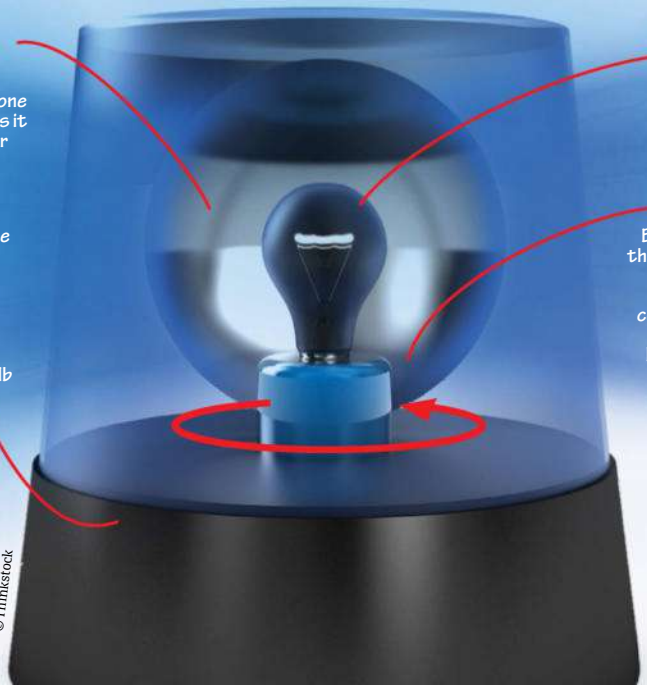
Emergency vehicle lights don't flash

Reflectors rotate in order to product a flashing illusion

Fixed to the top of service vehicles, flashing blue lights are deployed in the event of an emergency. Their bright flashes grab the attention of other road users from a distance, allowing them to take evasive steps in good time to make sure the emergency vehicle can pass through safely and quickly, even in heavy traffic, which is crucial when responding to an emergency call.

Although brighter, more efficient blue LED lights are now commonplace on police cars, ambulances and fire engines, the old-fashioned method of using a see-through unit with a single light bulb inside has long been a trusted ally of the emergency services – and its magic is in the illusion it creates.

Of course, bulbs can't keep flashing on and off for long periods or they'll blow, so the illusion is created by a rotating base with a vertical reflector affixed to it, moving around a fixed light bulb. The reflector redirects light outward from one side, while blocking the light out to the other. When the base is rotated fast, this creates the 'on-off' illusion of a flashing blue light atop an emergency vehicle.



DID YOU KNOW...

MULTI-SURFACE
The gloves can stick to any smooth surface including glass, plastic panels, painted or varnished wood panels and metal

SPRING-LOADED
The pads are connected to special springs that become less stiff the further they are stretched When the springs are released, the wedges revert back to an upright position, reducing the surface area and the attractive force

ADHESIVE TILES
Each glove is covered with 24 stamp-sized adhesive tiles, which are covered with slanted microwedges made of polymer

MICROWEDGES
Each wedge is just 100 micrometers long (roughly the diametre of human hair). When a force is applied, the microwedges bend over, causing a larger surface area to come into contact with the wall

Adhesive gloves make it possible to climb walls

Being able to scale skyscrapers like everyone's favourite web-slinging hero would make your morning commute more fun, but the secret to harnessing this power comes from geckos rather than spiders. Students at Stanford University have created special dry adhesive gloves that imitate the microscopic hairs found on a gecko's feet, enabling humans to implement the same scientific sticking principle they do. However, a gecko only weighs a few grams, so they had to come up with a clever solution to allow for the extra weight. This came in the form of special springs, which help to spread weight evenly across the gloves, providing sufficient adhesion to support up to 91 kilograms (200 pounds). Humans don't have the incredible upper-body strength of geckos, though, so a bit of extra help is required in the form of moveable rope ladders. Initial tests of the gloves have proven successful, and now the students are working with NASA's Jeyt Propulsion Lab to see if similar technology can be applied to the robotic arms of spacecraft to catch space debris.

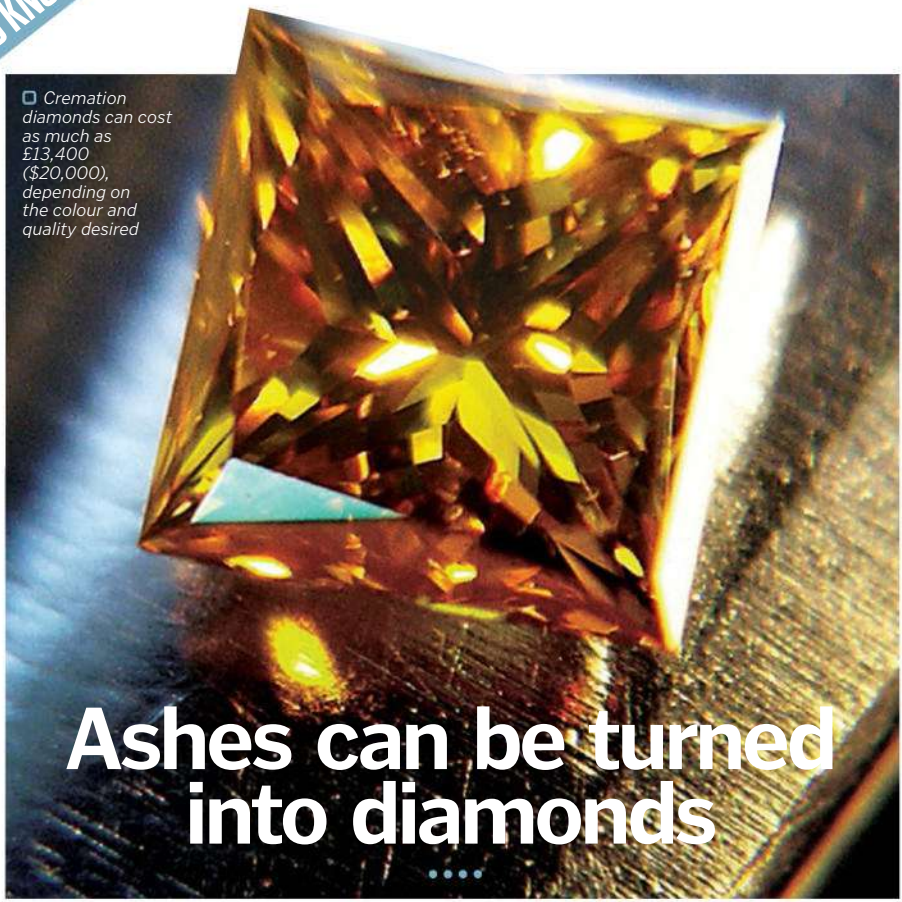
GET YOUR SPIDERSENSE TINGLING

The ability to predict an oncoming obstacle or villain is important for any superhero, but we mere mortals have just created a suit that can help us do the same. It may not look quite as slick as Spider-Man's skin-tight ensemble, but the SpiderSense suit can alert you to any person or object within a 152-centimetre (60-inch) radius, even if you're blindfolded. It contains several sensor modules, each containing a range finder and a servo motor. The range finder continually emits a sonar pulse that bounces off of any nearby obstacles, enabling a sensor to calculate its distance from you. When an obstacle is detected, the servo motor activates an arm that applies pressure on your skin. The closer you get to the obstacle, the more pressure the arm applies, allowing you to judge its proximity and act accordingly. Inventor Victor Mateevitsi hopes the tech can help the visually impaired and those in low-visibility situations, such as firefighters entering smoke-filled buildings, to navigate safely.

© EricEason

Sensors spread across your body can alert you to an oncoming obstacle in a matter of milliseconds

© Lance Long, Electronic Visualization Laboratory, University of Illinois at Chicago



Cremation diamonds can cost as much as £13,400 ($20,000), depending on the colour and quality desired

Ashes can be turned into diamonds

Knowing how to commemorate a loved one's passing is incredibly difficult for us all, but there is now a wide range of alternatives to traditional burial or cremation. An alternative to sending your relatives' ashes into orbit, a technique has been devised to convert them into diamonds. A typical 80-kilogram (176-pound) man produces enough ashes to make a 0.2-gram (0.007-ounce) diamond, as our bodies are 18 per cent carbon.

To do this, the ashes are heated to over 2,760 degrees Celsius (5,000 degrees Fahrenheit) in a heat-proof crucible. This works to oxidise all of the elements within the ashes, other than the carbon. The carbon is then heated for a number of weeks to turn it into graphite, which is then pressed with a metal catalyst and a diamond-seed crystal. This step requires temperatures of around 1,371 degrees Celsius (2,500 degrees Fahrenheit), along with extremely high pressures, and needs several weeks to convert the graphite into a rough crystal. This crystal can then be cut to specification and presented as desired. The finished diamond's colour is typically yellow or orange, depending on the amount of other trace elements within the original ashes. This can be changed by further enhancement techniques.

One application of the Splash nanosolution will make your phone water resistant for up to 12 months

Nanotechnology can make your phone water resistant

Accidentally spilling a glass of water over your phone can cause irreversible damage to the device. Of course, you could attach a waterproof case to make sure it is fully protected, but these often add a lot of bulk to your otherwise slim and sleek phone. However, now you can simply spray on an invisible water-resistant coating that is 1,000 times thinner than a human hair. Splash spray uses nanotechnology to create a small barrier of air around the phone to repel water molecules away from the surface and prevent them from getting inside. All you have to do is spray the openings and buttons on your phone and repeat the process three times, then spray a microfibre cloth and use it to buff the front, back and sides to remove any residue. The spray dries in ten minutes and makes your phone water resistant straight away. It will only protect your phone from spillages, though. Fully submerging your device will still allow liquid to enter the housing, causing damage to the elements inside.

DID YOU KNOW...

The Lytro Illum camera is available now for £1,299.99 ($1,599)

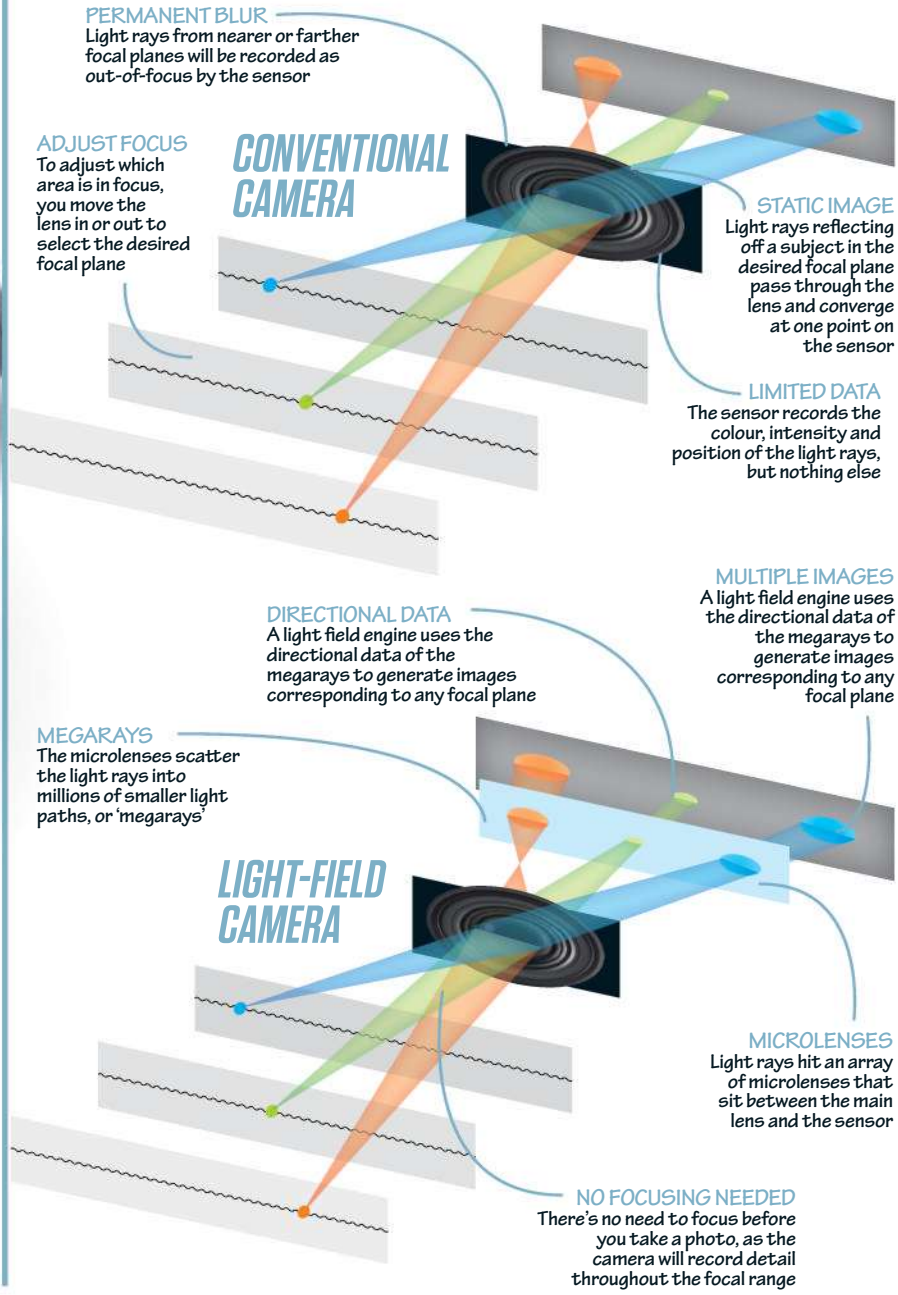
There is a camera that takes photos first and focuses later

Taking a photo only to discover your main subject is out of focus is a common and frustrating problem. It's okay if you can simply take the photo again, but what you don't notice the issue until you get home?

If you own a Lytro camera, you'll never experience this heartache again. Clever light field technology means you can refocus your photos – and even change the perspective – after you've taken them. It does this by using a microlens array and a special light field sensor to determine from which direction rays of light enter the camera. This allows it to record a multidimensional light field, which is passed through special software.

Complex algorithms are then able to simulate what the image would look like if you had focused on a different focal plane or taken it from a different angle and all of these possibilities are pieced together to create one adjustable image. Light field technology isn't new, but Lytro is the first to use it in a commercial camera. Its latest model is the Illum, which has an 8x optical zoom lens, ten-centimetre (four-inch) LCD screen and can shoot 3D images too.

CAPTURING LIGHT FIELDS



DID YOU KNOW...

Siri can be programmed to know who is in your family

Siri won't automatically know who you are. It's clever, but it's not that clever! You have to tell it who you are first, but you only need to do this once, and it stores the details. Go into Settings and then General, then select Siri from the list. Scroll down to My Info and then enter your details. When you next talk to Siri, it should address you by name. It also uses your personal information to tailor answers to your circumstances. For example, if you ask what the weather is like, it will give you the local forecast.

Talk to Siri and it will talk back, using your name

Early typewriters used lots of different key layouts until QWERTY eventually took over

QWERTY is more efficient to type with

That's because it's less efficient. An alphabetical keyboard would put A and E on the left and middle of the top row, and T on the left of the bottom row. These are the most uncomfortable places for touch typists to reach, for some of the most common letters in English. The alphabet is a random sequence of letters and there's no reason to suppose it has an advantage for keyboards. There are patterns that are theoretically more efficient than QWERTY. These layouts never took off, but alphabetic order is demonstrably worse than QWERTY.

This scanning electron microscope image shows superglue's adhesive surface close up

Water creates super-strong superglue bonds

The compound responsible for superglue's characteristic sticky strength is called cyanoacrylate, which is an example of an acrylic resin. As soon as it is placed on a surface it cures (forms its strongest bond) in an almost instantaneous reaction, requiring only the presence of the hydroxyl ions found in water for this to happen. Nearly all surfaces we encounter have trace amounts of water, as it is present in the air we breathe. This process is an example of anionic polymerisation; the cyanoacrylate molecules link together in a mesh when they come into contact with water, creating a super-strong bond. This differs from the way white glues bond which is by solvent evaporation.

Other than sticking two materials together, superglue can be employed in a variety of other settings. In forensic science, it can be used to visualise latent (invisible) fingerprints, as the superglue's vapours bind to the moisture that is deposited by the fingerprint, turning them white and visible. This reaction also stabilises the fingerprint's detail, making it possible for further enhancement to be carried out. A non-toxic version of superglue has also been created for surgery which can be used to seal the skin without the need for sutures.

DID YOU KNOW...

Stephen Hawking's wheelchair is controlled with one button

Stephen Hawking was diagnosed with amyotrophic lateral sclerosis (ALS) when he was 21. ALS is a form of motor neurone disease, which results in the progressive death of the nerves that control the muscles. Most sufferers die within five years, but fortunately for physics, and for Professor Hawking himself, his disease has progressed extremely slowly. Even so, at the age of 73, Hawking has just a small amount of motor function left, mainly in the muscles of his face. His link to the world is provided by the computer technology built into his wheelchair.

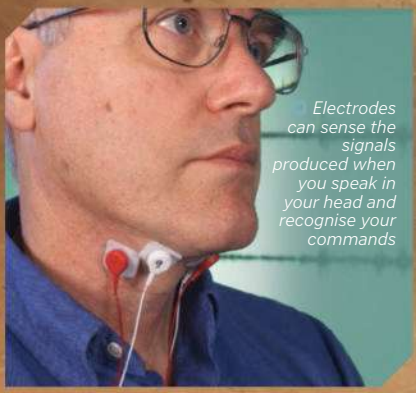
Professor Hawking controls all the functions of his tablet PC using just a single switch – imagine operating your PC using nothing but the spacebar!

Hawking's PC uses a special interface called EZ Keys, which scans across each letter of the on-screen keyboard, one at a time. When Hawking moves his cheek, a sensor detects the movement and the computer halts the scanner and picks that letter. He can also use this process to scan from one button or menu item to the next, and so control his email program (Eudora), web browser (Firefox) or even make calls over Skype.

As Hawking's physical condition gradually deteriorates, his typing speed has dropped to just one or two words per minute. Scientists at Intel compensate using algorithms tailored to Hawking's vocabulary and writing style, which accurately predict which words he will want to use next.

THOUGHT-CONTROLLED WHEELCHAIRS

When you speak, your brain sends nerve signals to your throat, even if your muscles aren't strong enough to actually make audible sounds. In fact, this subvocal speech happens even if you just think the words in your head. Technology originally developed at NASA Ames Research Center is now available as a way for severely disabled people to control a motorised wheelchair or send their thoughts to a speech synthesiser. The user wears electrodes stuck to the skin of their throat and simply thinks command words such as 'go left' or 'stop'. The tiny electrical impulses are detected and decoded and the right command is sent to the wheelchair. Hawking has tried brain interfaces like this but they are still too inconsistent for him. At the moment, slight shifts in the placement of the electrodes can see the recognition rate drop from 94 per cent to less than 50 per cent.



Electrodes can sense the signals produced when you speak in your head and recognise your commands

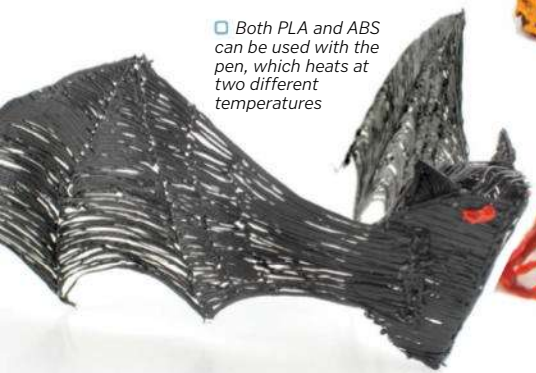
CHAIR OF PHYSICS

DID YOU KNOW...

The 3Doodler lets your draw in the air

The world's first 3D-printing pen – WobbleWorks's 3Doodler – was launched on KickStarter in 2013, where it received over £1.3 million ($2 million) in funding in just 34 days. This gizmo enables you to turn drawings into full-3D models on any surface, without the need of any software or computer. Unlike a normal pen, however, the 3Doodler doesn't use ink, instead relying on filaments of ABS or PLA plastic, materials also used by most desktop 3D printers.

Similar to its more expensive desktop counterparts, the 3Doodler prints by heating three-millimetre (0.1-inch)-thin strands of plastic, which need to be loaded into its back. After turning the 3Doodler on and waiting a few minutes for it to warm up, the LED indicator light will turn blue, which means the heated plastic can then



Both PLA and ABS can be used with the pen, which heats at two different temperatures

The 3Doodler allows anyone to draw straight into the air by heating ABS or PLA plastic

extrude from the 3Doodler nozzle's metal tip – the only potentially dangerous part of the pen, which can get as hot as 270 degrees Celsius (518 degrees Fahrenheit).

Once the heated plastic leaves the nozzle, it quickly solidifies into a strong, stable structure, allowing you to build shapes with ease. Because the heated plastic can be drawn over almost any surface, including other plastic, even items like an iPhone case can be personalised in a variety of colours.

There are two temperature settings so users can switch between the different melting points of ABS and PLA, and two main speed control buttons allow for the heated plastic to flow quicker or slower. This makes it possible to create large items with a sizeable area to fill, as well as more intricate, delicate details.

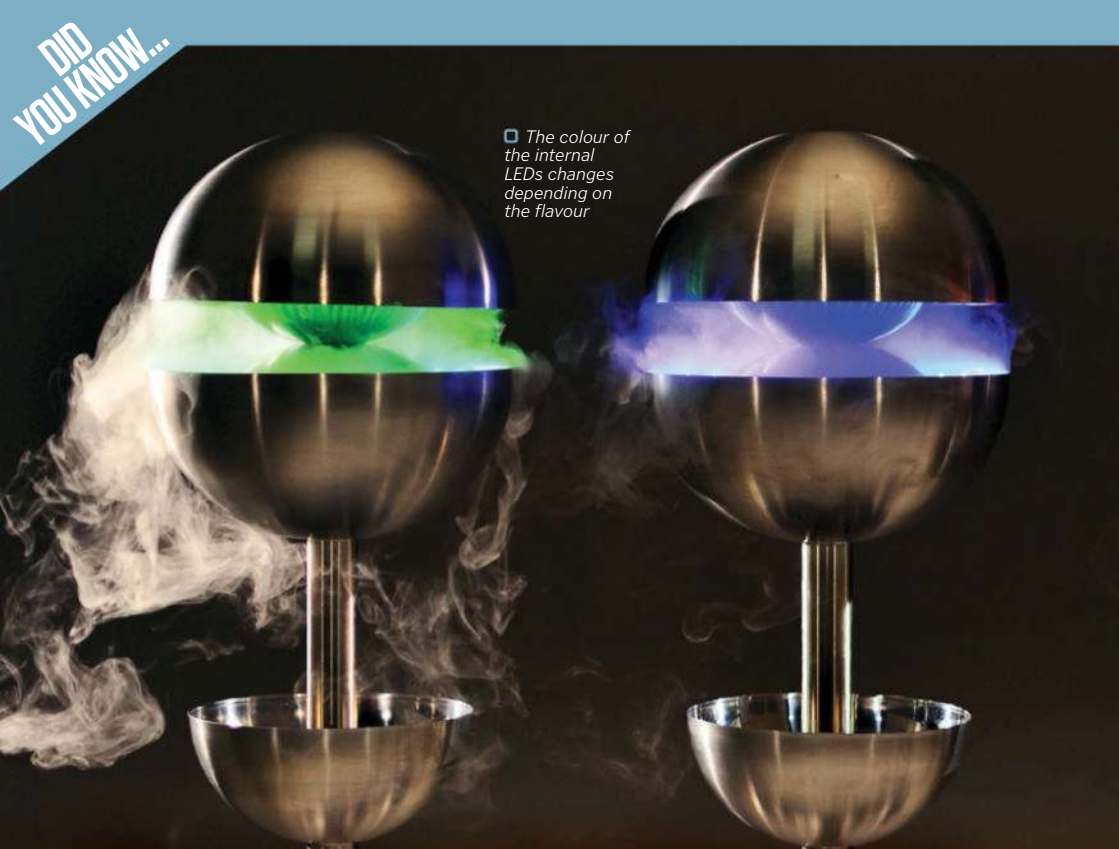
The 3Doodler allows you to create whatever you want out of plastic

THE DIFFERENCE BETWEEN ABS VS PLA FOR 3D PRINTING

One of the most common plastics around today is ABS, or Acrylonitrile Butadiene Styrene. Made of oil-based resources, it's much stronger and less likely to snap when bent compared to PLA, and has a higher melting point at 225 to 250 degrees Celsius (437 to 482 degrees Fahrenheit) for the 3Doodler. It forces out a more flexible material from the pen, and is easier to peel off of paper than the 3Doodler PLA. In traditional 3D printing, ABS is a plastic that can easily deform if not being printed on a heated surface, such as a heated build platform.

PLA, or polylactic acid, is a biodegradable polymer, it's considered better for the environment when properly recycled. It also comes in a huge variety of colours and can even be translucent. Due to the lower melting point of 190 to 240 degrees Celsius (374 to 464 degrees Fahrenheit) for the 3Doodler, PLA is more prone to overheating and can droop if it gets too hot. It also adheres very well so may not be suitable for peeling off paper like ABS is; but this is an plus for mixed media, such as sticking 3Doodle creations to a glass surface.

DID YOU KNOW...



The colour of the internal LEDs changes depending on the flavour

There is a machine that creates edible mist

The Edible Mist Machine uses ultrasonic vaporisation to create flavoured mist. Rhys Saunders from Lick Me I'm Delicious, the company that made the machine, explains the technology behind the process: "The liquid is made up of flavour essences mixed with a water solution to create the optimum viscosity to carry flavour and still produce a mist. The mist is created by pulsing ultrasonic vibrations through the liquid."

When the mains-powered unit vibrates at a frequency of over 20 kilohertz, the water absorbs the energy of the vibrations. The water droplets begin to vaporise as mini-currents start to flow throughout each droplet, dispersing the molecules. This creates the mist, which rises up through the central tube into the upper bowl.

The curved shell design pushes the mist out toward the user while the domed top keeps it from escaping. Once here the flavoured mist can be sucked up through straws providing a calorie-free taste sensation. The LEDs change colour with on the flavour.

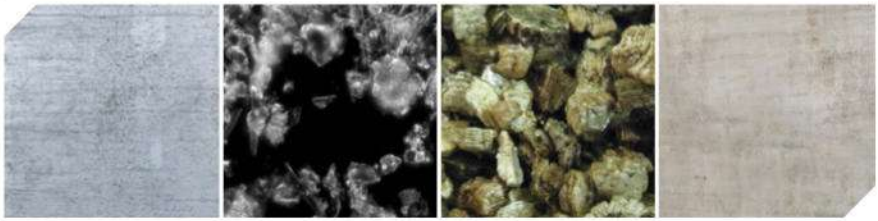
The chances of cracking a combination safe is one in 941,094

The term "a safe" was first used in the 1800s to describe a chest or cupboard that was not only thief resistant, but could also fend off flames and withstand falling buildings. The modern-day safe still upholds this mantle and has been designed to endure most types of attack.

Today, safes are typically constructed with two pieces of steel that sandwich a specially treated piece of concrete. This concrete has diatomaceous earth (containing prehistoric fossils) and vermiculite added to it, to enhance its strength. There are now a number of different types of lock available to operate a safe's door. Modern day technology such as retina or fingerprint scanning is available, but still comes at a hefty premium.

The most commonly used lock is still the combination variety, which typically requires the user to enter three different numbers to gain access to the treasures that are inside. But the chance of guessing this combination is one in 941,094, making it extremely hard to crack.

HOW A SAFE RESISTS DAMAGE



STEEL
The outer wall is made up of two thick pieces of steel that are sandwiched together the specially treated concrete layer.

DIATOMACEOUS EARTH
This earth is rich in silica, which gives the concrete an incredibly high melting point of over 1,700°C (3,902°F).

VERMICULITE
Vermiculite is also mixed in with the concrete which has a popcorn-like structure that helps prevent heat from damaging the safe's contents.

CONCRETE
Although steel is incredibly tough on its own, the addition of a concrete layer makes the overall structure much harder to infiltrate, especially with a drill.

DID YOU KNOW...

The Wimbledon roof spans 5,200 square meters

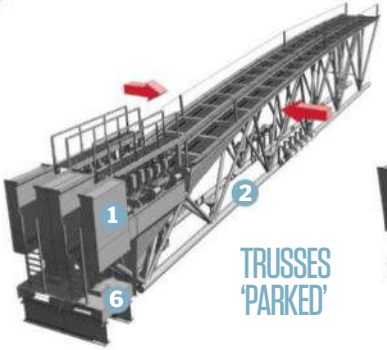
Tennis is a sport that requires good weather, so it's surprising that one of its premier competitions has been held in rainy England since 1877. So after 132 years, a roof was built on Wimbledon's Centre Court for the 2009 Championships. The primary function is to keep water off of Centre Court so games can continue when a downpour begins, but it also means games can continue after dark.

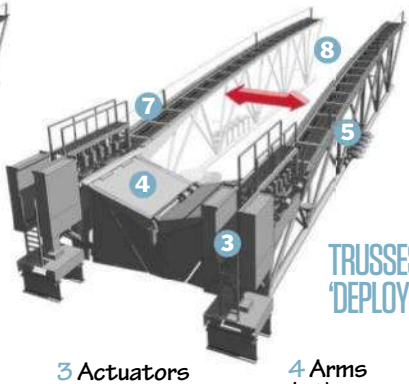
The roof spans 5,200 square metres (56,000 square feet) and is made up of a membrane held up by ten steel trusses, each weighing around 70 tons.

It only takes around eight minutes to close but the lights and air management system take up to half an hour to get working. The roof cuts out 60 per cent of the natural light so 120 specialist sports lights are used to provide the correct lighting levels. The AC system regulates the temperature and removes moisture from inside the stadium so conditions are as similar to a roofless atmosphere as possible.

The roof has revolutionised one of the world's most famous sporting events by allowing matches to go on while the traditional rain is lashing down.

HOW A SAFE RESISTS DAMAGE





1 Control gear boxes
They operate the actuators.

2 Trusses
Each of the ten steel trusses that span the court weighs 70 tons.

3 Actuators
Electronic actuators push down on the arms between the trusses.

4 Arms
As the arms are pushed, they spread the trusses apart.

5 Lights
120 sports lights are carefully arranged so the court is evenly lit.

6 Bogies
The trusses run on these wheeled trolleys that run along a rail.

7 Locking arms
Arms across the top of the roof lock in place to withstand wind and rain.

8 Time
It takes about eight to ten minutes for the roof to close.

DID YOU KNOW...

New fighter pilot helmets offer goggleless nightvision

Fighter aircraft usually have displays built into the windscreen so the pilot can see the information coming from their instruments (speed, altitude, warnings and such) without needing to look down. This might seem a small thing, but if you are in the midst of a dogfight, taking your eyes off your adversary even for a second could be deadly. Rather than using a projector to shine the data onto the windscreen, though, the new Striker II has incorporated the display into the helmet.

A tiny projector shines the data onto the inside of the helmet's visor – kind of like the display inside the Iron Man suit – directly in front of the pilot's eyes. Not only does this mean the instrument information is always in view but the

Striker also uses motion sensors to track where the pilot is looking.

BAE has taken advantage of this display technology to incorporate night vision. Night-vision goggles are already used in fighter aircraft, but they have to be put on when needed. On top of that, they are hefty pieces of kit, which can add to the load on the pilot's neck. Instead, the Striker II has a compact night-vision camera in the top of the helmet. This keeps the weight of the system in line with the head instead of hanging off the front. The night-vision picture is then combined with the helmet display so the pilot does not need to change over to the goggles and when they look around they have a synchronised view of the outside world, whatever the time of day.

DID YOU KNOW...

Caching is why you should eject a USB stick

Because some operating systems use 'write caching'. This is where the computer pretends your file has been saved, but the changes are in fact just stored in working memory, and only copied to the disk when its less busy. If you pull the USB drive out while there are still write commands waiting in the cache, you could lose data. This is only a problem if you yank the USB drive out within a few seconds of your last save, and it doesn't apply to modern Windows computers, because write caching is turned off for USB drives by default.

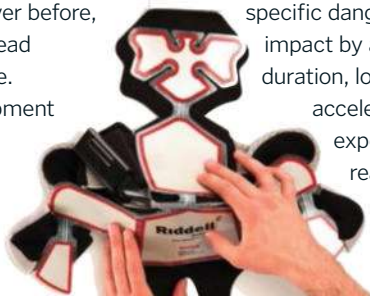
Mirrors control camera auto-focus

There are two mirrors in an SLR camera, and you can change the orientation of these using the focus ring. A display inside the viewfinder allows you to see when the images from the two mirrors line up. Two electronic sensors are used to look at the views from the two mirrors. A computer chip inside the camera then takes the two images from the sensors and compares the pattern of light and dark to find where they overlap and therefore the distance of the object. The computer then tells the focus ring to turn to the right distance, focusing on the object.

NFL players use their helmets to measure impact

According to the NFL's data, 692 concussions were diagnosed in players between 2012 and 2014. Furthermore, 79 deceased NFL player autopsies; 96.2 per cent of the subjects had suffered from a degenerative brain disease called chronic traumatic encephalopathy (CTE). Players are bigger and faster than ever before, making the dangers of head trauma even more severe.

American sports equipment company Riddell has designed the InSite Impact Response System (IIRS) to help reduce the risk of this. The system is composed of the Player Unit, Alert Monitor and Player Management Software. The Player Unit lines the helmet, and features a five-zone sensor pad measuring impact severity. This reports when a player experiences a singular or set of impacts exceeding a specific danger threshold. It measures impact by assessing the effects of duration, location and the type of acceleration the head experiences, combining these readings for the most accurate assessment.



DID YOU KNOW...

The colour of sunset is determined by the wavelength

The electromagnetic radiation given off by the Sun contains a wide spectrum of wavelengths, and human eyes are sensitive only to certain parts of it. The colours we see depend not only on what our eyes are sensitive to, but also on what has happened to the light before it has reached us and how the Sun is reflecting it, because different colours are associated with different wavelengths according to the spectrum. When the Sun sets, its position in the sky is low compared to where it sits in the middle of the day. Therefore, the light emitted has to take a different path. Its longer journey through the atmosphere means the colours with shorter wavelengths, such as blues and greens, are scattered and dispersed by the atmosphere, leaving mostly reddish components of light (those with longer wavelengths) to reach our eyes.

"The colours we see depend not only on what our eyes are sensitive to, but also on what has happened to the light"

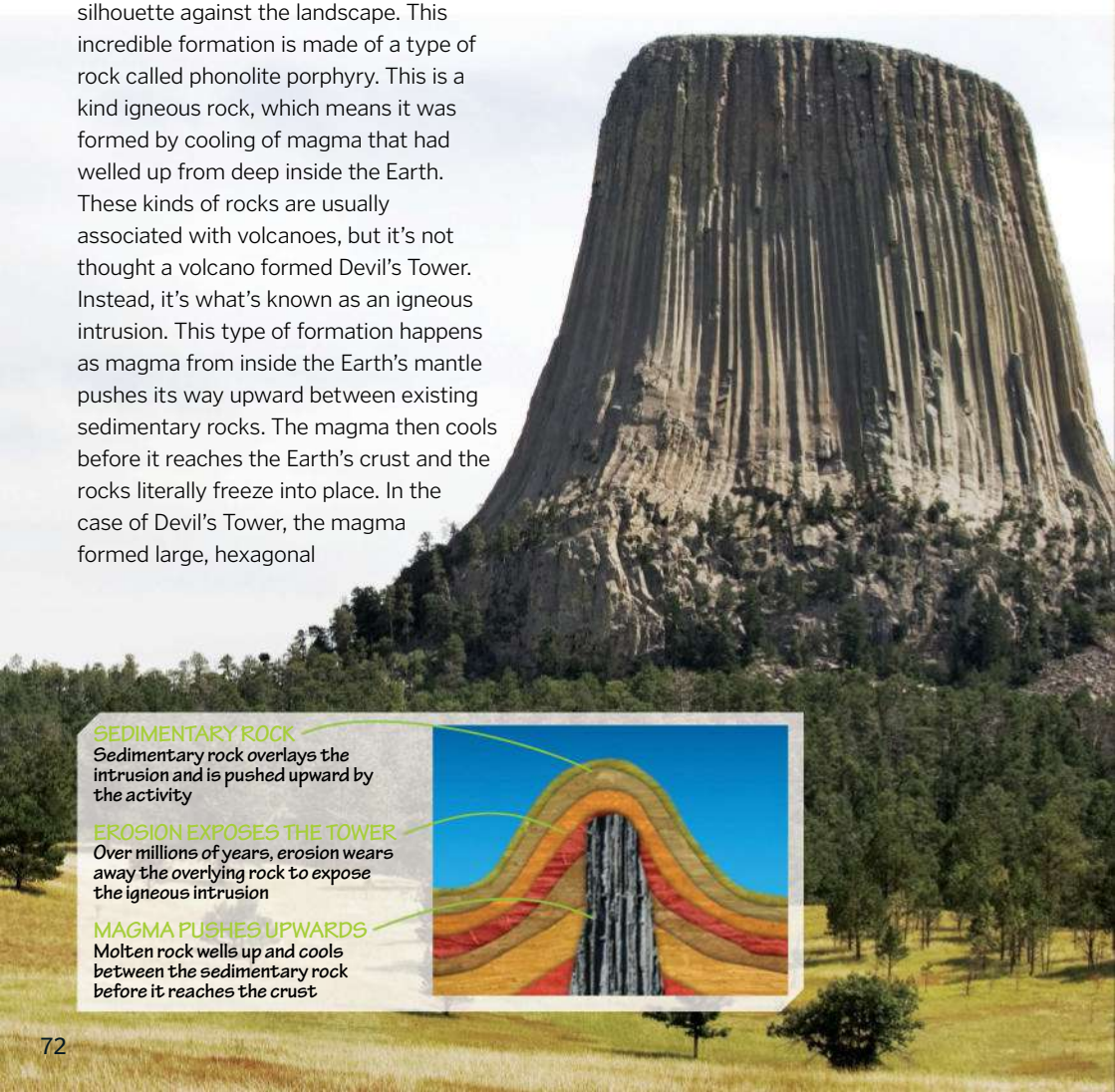
THE SUNSET SPECTRUM

The colours that the Sun's light casts in the sky is entirely dependant on its position, and how the light is cast through the particles in the atmosphere. Long journeys produces red, but shorter journeys produce yellows and blues, depending on their place on the spectrum of light.

DID YOU KNOW...

Devil's Tower was formed by cooling magma

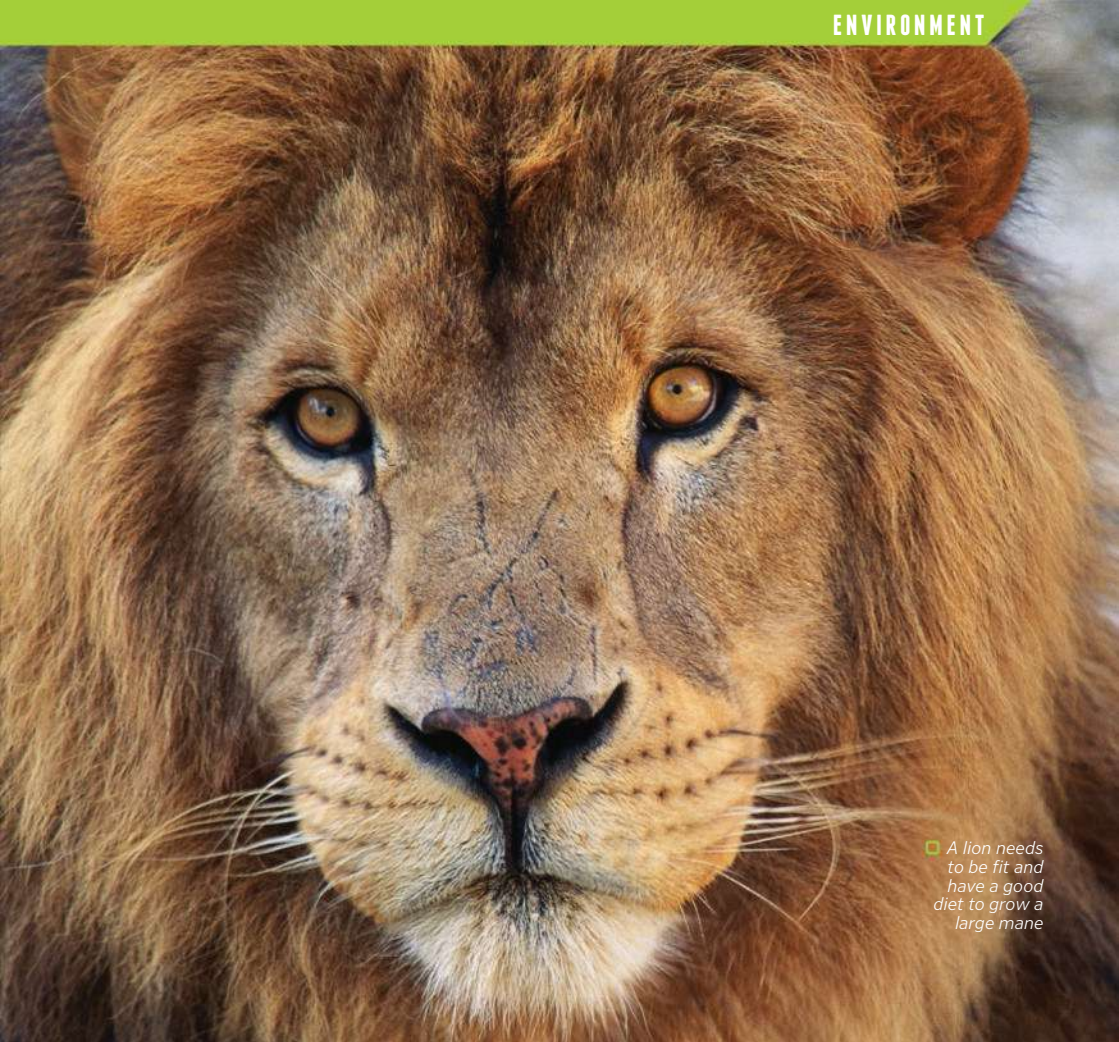
Devil's Tower is a huge rock formation that juts out of the ground in northeastern Wyoming in the United States. It is a 386-metre (1,267-foot)-high chunk of solid rock that forms a striking silhouette against the landscape. This incredible formation is made of a type of rock called phonolite porphyry. This is a kind igneous rock, which means it was formed by cooling of magma that had welled up from deep inside the Earth. These kinds of rocks are usually associated with volcanoes, but it's not thought a volcano formed Devil's Tower. Instead, it's what's known as an igneous intrusion. This type of formation happens as magma from inside the Earth's mantle pushes its way upward between existing sedimentary rocks. The magma then cools before it reaches the Earth's crust and the rocks literally freeze into place. In the case of Devil's Tower, the magma formed large, hexagonal columns as it cooled. It's thought this formation happened within the Earth, and the continuous erosion of wind and rain has slowly exposed the Devil's Tower we know today.



SEDIMENTARY ROCK
Sedimentary rock overlays the intrusion and is pushed upward by the activity

EROSION EXPOSES THE TOWER
Over millions of years, erosion wears away the overlying rock to expose the igneous intrusion

MAGMA PUSHES UPWARDS
Molten rock wells up and cools between the sedimentary rock before it reaches the crust



A lion needs to be fit and have a good diet to grow a large mane

A male lion's mane determines its strength

It is believed that the mane evolved to protect a lion's neck in a fight; however, Peyton West from the University of Minnesota led a trial involving dummy lions and discovered that, actually, it's not often the neck that is targeted. The real lions attacked the dummies but mainly went for the backside. While it is thought that during evolution the mane served as protection, now the mane acts as a sign of strength.

The mane can overheat a lion and makes them stand out to predators, so only the strongest survive with a large mane. Females are attracted to this, and other lions pick fewer fights.

DID YOU KNOW...

A usual cuppa comes from the Camellia plant

Tea, the hot beverage enjoyed so much in the UK that it has become as quintessentially British as the Queen, begins its life as juicy young leaves on a bush of the Camellia family. The species Camellia sinensis originates from China and the Camellia sinensis assamica variant is the Indian tea variety. Tea bushes are grown in vast crops in hot, humid areas with regular rainfall. China, India, Sri Lanka and Kenya are the top four countries, representing 75 per cent of the world's tea production. Factors such as climate, altitude and humidity affect the quality and taste of the tea crop – much in the same way as grapes and wine – and their leaves are expertly selected and plucked by hand.

Black tea, the kind you're probably enjoying with milk and one sugar as you read this, is made from new, tender tea shoots, typically the first few leaves and a bud. Once picked, the leaves go through four main steps before they're ready for brewing and accompanying some cake: withering, rolling, oxidation and drying. For different tea varieties, these steps are modified and adapted, which helps to produce such a huge array of different tea flavours and types.

FROM PLANT TO CUP

PLUCKING

Leaves are never plucked from the plant individually; they are always removed as a group of one, two or three leaves along with the bud that forms at the end of the stem

THE PLANT

Tea leaves grow on bushes in vast crops. If left untended the tea plant could reach up to 20m (65ft) tall, but the bushes are usually pruned at the 'plucking table' around 1.2m (4ft) – this helps hand-picking and promotes bud growth

DRYING

Tea leaves are then dried in order to stop the oxidation process at precisely the right time to make sure the tea's flavour is just right. The oxidised leaves are gently heated to remove all excess moisture

PACKAGING

After the tea is dried, it is sorted into grades depending on the dried leaf's size. Larger leaves are sold for loose-leaf tea and smaller ones are prepped for use in tea bags

DIFFERENT TYPES OF TEA

The four main types of tea are black tea, green tea, white tea and oolong tea. They all originate from the same plant, and it is their preparation that defines their taste. White teas only use the very first buds at the top of a new season's tea plant, which can only be plucked once a year. All four types of tea leaves are withered first – a process that reduces the moisture content.

Once withered, leaves for making green tea are then steamed or pan-fried. This stops the oxidation process – meaning there is no further reaction with oxygen – which is why the leaves keep their natural green colour, giving the tea its name.

Oolong tea is semi-oxidised, placing it somewhere between green and black tea. The partial oxidation allows the leaves to briefly ferment, producing a more distinctive flavour. The leaves are then rolled and dried ready for brewing.

WITHERING

The freshly picked leaves are laid out in large troughs or shelves to wither for eight to 12 hours. Air is often passed through in order to help the removal of moisture, and after withering the leaves look wilted

ROLLING

The leaves are broken up and the enzymes are released in preparation for oxidation. There are two rolling methods: Orthodox, where rollers gently break leaves; and CTC – cut, tear, curl – where leaves are cut by a machine

OXIDISING

The withered and rolled tea leaves are laid out for a few hours to oxidise, which means they react with oxygen and begin to ferment. The leaves undergo chemical processes where they partially break down

THE CUP

The tea is then ready for brewing. The dried tea leaves infuse hot water with the delicate taste that's governed by the growing conditions and careful preparation process. Pop the kettle on!

DID YOU KNOW...

"Every day, an epic migration can be witnessed within the lake, as the jellyfish move to the eastern side of the lake in the morning and then back west again in the evening"

Scuba divers can't go beyond 15m deep in Jellyfish Lake

Found off the coast of Koror, Palau in the Philippine Sea, a rocky island uninhabited by humans is host to a colossal colony of jellyfish. The Ongeim'l Tketau marine lake, more commonly known as Jellyfish Lake, is just one of about five Palauan lakes inhabited by these glutinous beauties. The lake itself is an average of 30 metres (98 feet) deep and is connected to the sea by cracks and fissures in the rock.

The unusual chemical parameters of the lake mean it is highly stratified. The uppermost 'layer' of water is rich in oxygen, but around 15 metres (49 feet) beneath the surface the anoxic bottom layer begins – an oxygen-depleted zone high in hydrogen sulphide that makes the depths of the lake a no-go area for scuba divers.

However, swimming in the top layer is permitted – and recommended – as the whole water body is teeming with both golden jellyfish and moon jellyfish species. Neither species' stings are dangerous to humans.

These fascinating animals are able to grow to such large numbers as the lake provides a safe, enclosed ecosystem with very few natural predators. However, there is one sea anemone species living in the lake that has a definite taste for a jellyfish supper.

Every day, an epic migration can be witnessed within the lake, as the jellyfish move to the eastern side of the lake in the morning and then back west again in the evening, tracking the progress of the Sun. It's thought that this daily migratory behaviour helps the jellyfish avoid the shady shoreline areas where the jelly-hungry anemones can be found lurking in wait for an easy meal.

The lake is filled with golden and moon jellyfish

DID YOU KNOW...

A ladybug can live up to two years

Animals' lives revolve around eating, and ladybirds are no different. Aphids, or greenflies, are a vital source of food for the 5,000 species of ladybird, but aphid colonies swell and shrink rapidly.

Ladybirds time their reproduction with the growth of an aphid population to ensure their offspring will have enough to eat.

There is more on the menu than aphids, however. Ladybirds also feast on plant matter and other insects, but females are more efficient feeders. They are significantly larger than males and are generally more active. They use a lot of energy searching for sites suitable for laying eggs, while males mainly just spend their time searching for females.

To defend against bird predators, ladybird bodies are full of a chemical called precoccinelline. This is toxic, and their red colour acts as a warning to would-be scavengers. The quality of a young ladybird's diet dictates how poisonous it will be as an adult, which is why ladybirds eat up to 5,000 aphids in their lifetime.

A ladybug's diet consists mostly of aphids and other insects

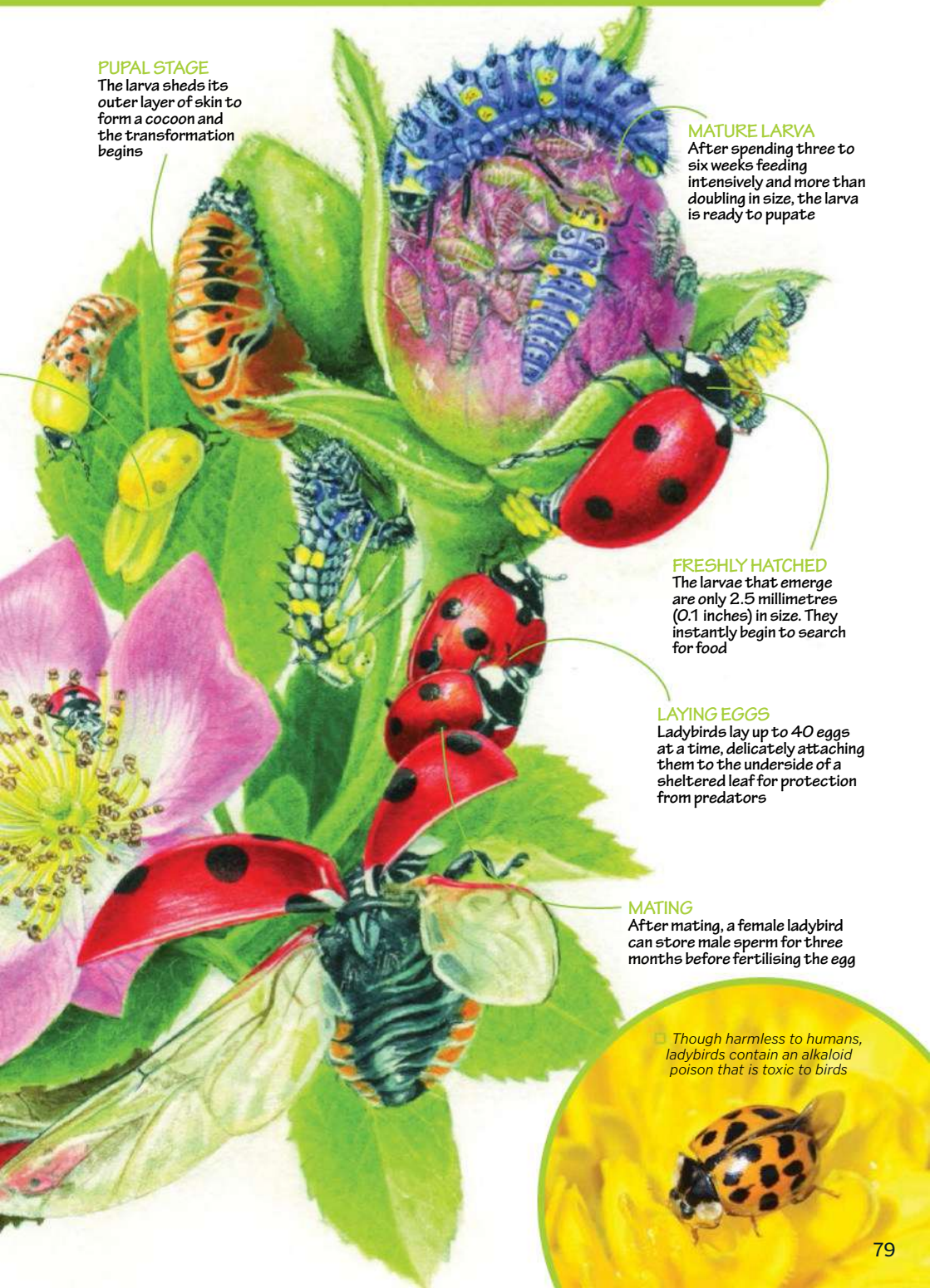
THE LADYBUG LIFECYCLE

NEWLY EMERGED

After seven days of pupating, the insect escapes its cocoon in adult form. It quickly changes from pale yellow to a glossy red

HIBERNATION

When the temperature drops, ladybirds seek shelter in which to hibernate, such as tree holes or even inside houses



PUPAL STAGE
The larva sheds its outer layer of skin to form a cocoon and the transformation begins

MATURE LARVA
After spending three to six weeks feeding intensively and more than doubling in size, the larva is ready to pupate

FRESHLY HATCHED
The larvae that emerge are only 2.5 millimetres (0.1 inches) in size. They instantly begin to search for food

LAYING EGGS
Ladybirds lay up to 40 eggs at a time, delicately attaching them to the underside of a sheltered leaf for protection from predators

MATING
After mating, a female ladybird can store male sperm for three months before fertilising the egg

Though harmless to humans, ladybirds contain an alkaloid poison that is toxic to birds

DID YOU KNOW...

Cats react to an active ingredient in catnip called nepetalactone

It's the oil in catnip that makes felines go crazy

There is an oil found in the catnip plant called nepetalactone. Researchers believe that when this oil enters a cat's nasal tissue, it binds to protein receptors that stimulate sensory neurons. This leads to a response in neurons in a part of the brain known as the olfactory bulb which projects to other brain regions; regions that not only mediate emotional responses to stimuli (causing a behavioural response), but also regulate neuroendocrine responses, making the cat react to an artificial cat pheromone. It doesn't affect all cats, but many react by rolling around, flipping over, becoming hyperactive and sometimes acting aggressively, before experiencing a come down ten minutes later.

An average cloud weighs 500 tons

If you consider the weight of the water droplets the average cloud contains, it weighs in at around 500 tons. Clouds are made up of tiny droplets of water or ice crystals, suspended in the air. On average, a cumulus-type cloud – the white, fluffy type – has a volume of one cubic kilometre (0.24 cubic miles), containing 0.5 grams (0.018 ounces) of water per cubic metre (35 cubic feet). This adds up to a total of 500 tons, although in reality this can vary significantly based on the size of the cloud. Despite this huge weight, clouds still float because the dryer air below them is denser.

White waves are caused by lots of water droplets

The white foamy surf we see in breaking waves as they come in to shore is actually made up of lots of tiny droplets containing bubbles of air. These air bubbles do not absorb as much light as pure water droplets, so the light that has passed through them is brighter than the surrounding sea.

This is what usually gives surf its white appearance. This effect is more noticeable when seas are rough because the churning waves produce more aeration and therefore more bubbles. Pollution or dissolved organic matter in the sea (often produced by the decay of algal blooms) can also create white foam along the shore.

Only the breaking part of the wave appears white; the rest of the water remains transparent

The honey badger holds the World Record for most fearless animal

When you think of badgers, you probably imagine shy, snuffling woodland creatures with pretty, striped faces. Brace yourself, because the honey badger – despite its sweet name – is a whole different mouthful of teeth. In fact, it holds the official Guinness Book of World Records title for most fearless animal in the world!

Despite their name, honey badgers actually have more in common with weasels than they do with the other badger species. Around one metre (3.3 feet) in length and 30 centimetres (12 inches) tall, their bodies are squat, stocky and incredibly strong, and they move with a self-assured trot. They're nocturnal and generally solitary, and a large brain-to-body size ratio makes them master problem solvers.

Honey badgers are also ferocious fighters, all rattling snarls and vicious

WHAT'S ON THE MENU?

Literally everything. Honey badgers are eating machines with high metabolisms, meaning they're constantly on the lookout for food. As their name suggests, they have a penchant for honeycomb; in particular the protein-rich bee larvae, which they will climb trees and shrug off hundreds of stings to secure.

As much as half of a honey badger's diet is made up of venomous snakes like puff adders. Even if they get bitten in battle, the relentless attackers are seemingly resistant to snake venom and apparently able to sleep off its effects in just a short time.

They also enjoy eating rodents, reptiles, birds, insects, small mammals, carrion and trash, and will just as soon scavenge as hunt. Where they cross paths with human residences, honey badgers will rifle through bins and ransack homes and kitchens, earning them the title 'masters of mayhem'.

lunges. They don't think twice about giving attitude to hyenas – animals five times their weight, with jaws more powerful than a lion's – and are reported to go for the scrotum. One account even tells of three honey badgers teaming up to chase a group of seven lions from their kill.

It may sound like the honey badger has a death wish, but this crazy little critter has every reason to be so bold. Virtually no predator can get the better of it, thanks to its secret weapon: its rubbery skin. At over half a centimetre (0.2 inches) thick, it is almost impenetrable to sharp objects, including spears, scorpion stings, and porcupine spines. Because the skin hangs loose around its muscular frame, a caught honey badger is able to twist right around and sink its vicious teeth and claws into its attacker's face. It can take a fully-grown leopard an hour to kill one of these tenacious little beasts!

DID YOU KNOW...

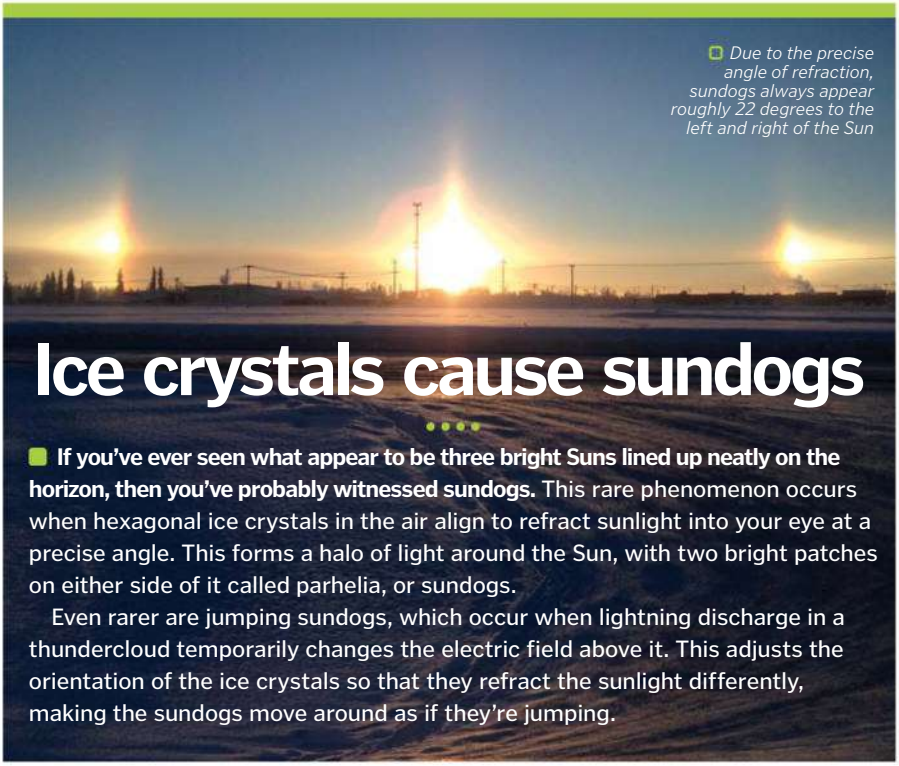
Frost flowers grow on frozen lakes

They may look like strange plants or even sea creatures, but these beautiful formations are actually intricate ice sculptures that grow naturally on thin ice. They have been spotted on frozen lakes, ponds and sea ice, but require very specific conditions to form. The air above the surface of the ice must be still, dry and about 20 degrees Celsius (68 degrees Fahrenheit) colder than the temperature of the ice itself. This makes it possible for the surface ice to sublimate, meaning that it changes directly from a solid to a gas, skipping the liquid stage in-between. As this water vapour hits the cold air above the ice, it condenses to form ice crystals that attach to imperfections or cracks on the surface. With little wind, the crystals do not blow away, and are left to grow naturally into stunning frost flowers. As they grow, the flowers also draw up more water from the ice below, and this often contains microorganisms. The density of bacteria found in frost flowers means that each one is its own ecosystem.

Frost flowers are typically found in the Arctic and Antarctic

Horns are permanently attached whereas antlers fall off

Horns, unlike antlers, are a permanent fixture, and are really an extension of the animal's skull. They are typically found on bovine animals like cattle, antelope and bison. Most horns are made up of bone surrounded by proteins and keratin, the same stuff our hair and nails are made of. Antlers on the other hand, which are commonly sported by male deer, reindeer and moose, will grow and shed seasonally in order to attract a mate and ward off potential competition during the mating season. They grow from the pedicle, which is positioned above the animal's skull, and are made up entirely of bone.



Due to the precise angle of refraction, sundogs always appear roughly 22 degrees to the left and right of the Sun

Ice crystals cause sundogs

If you've ever seen what appear to be three bright Suns lined up neatly on the horizon, then you've probably witnessed sundogs. This rare phenomenon occurs when hexagonal ice crystals in the air align to refract sunlight into your eye at a precise angle. This forms a halo of light around the Sun, with two bright patches on either side of it called parhelia, or sundogs.

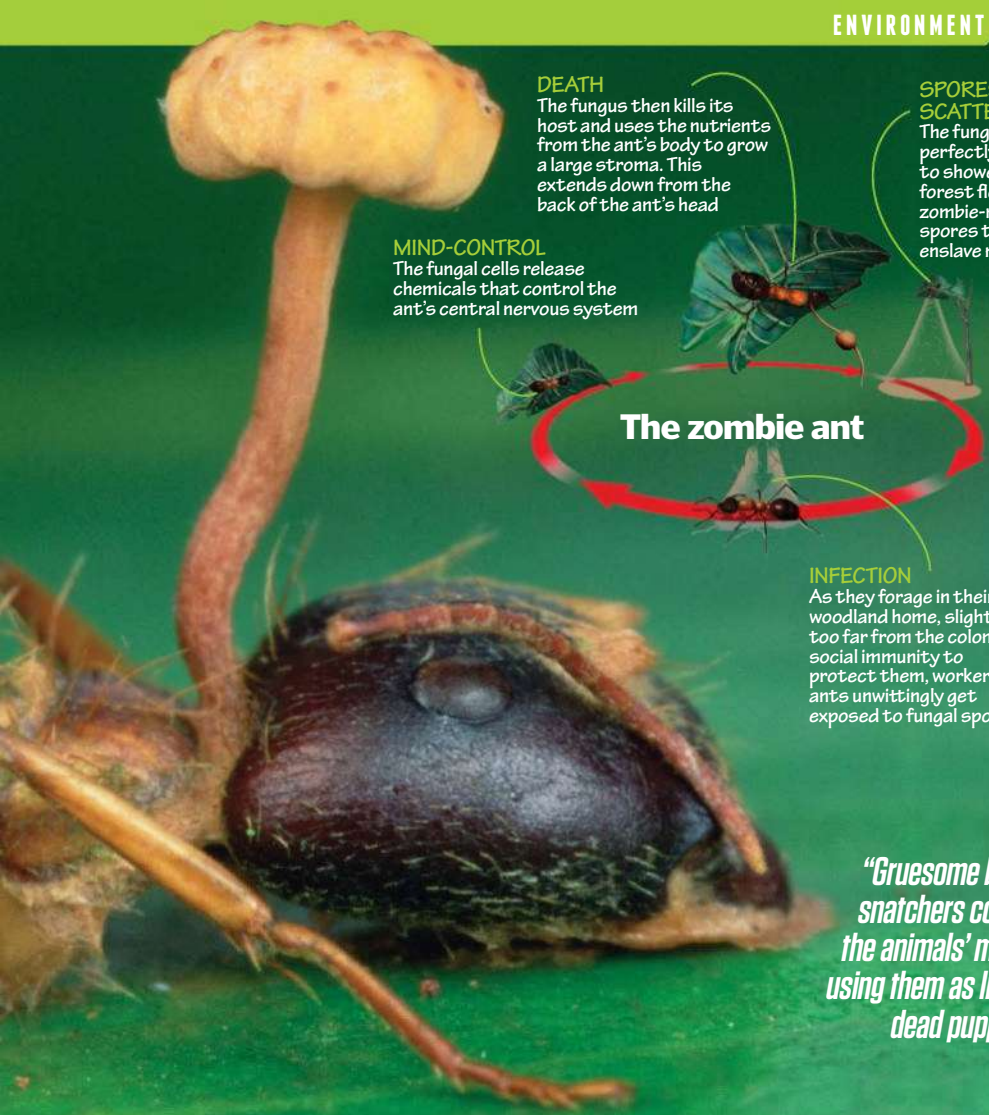
Even rarer are jumping sundogs, which occur when lightning discharge in a thundercloud temporarily changes the electric field above it. This adjusts the orientation of the ice crystals so that they refract the sunlight differently, making the sundogs move around as if they're jumping.

DID YOU KNOW...

There are real-life zombie animals

They're not quite the classic brain-eating, gormless slow-shufflers of horror movies, but for some species, the zombie threat is very real. The culprit? Parasites: small organisms with complex life cycles that set up camp inside their animal hosts. These gruesome body-snatchers are able to control the animals' minds, using them as living-dead puppets and steering them to positions of optimal benefit. One classic case is the zombie ant. The parasite is a mind-controlling fungus that manipulates carpenter worker ants into straying far enough from the colony that their social immunity is impaired. The fungus makes the ant bite down underneath a leaf, where it is anchored until it dies, then the ant's corpse is used by the fungus to grow. The fungus also releases spores that rain down and infect more ants, and so it continues.

One insect group responsible for zombifying its victims and turning them



"Gruesome body-snatchers control the animals' minds, using them as living-dead puppets"

into mindless drones are wasps. The jewel wasp (Ampulex compressa) injects venom directly into the brains of cockroaches, targeting two specific locations that render the roach's free will useless. The wasp leads the cockroach to a burrow and lays an egg on the roach's abdomen. The zombie roach only dies once the egg hatches and the larva devours it piece by piece.

Another wasp species, the green-eyed wasp (Dinocampus coccinellae), makes light work of harnessing the power of the ladybird. The wasp lays her eggs inside the bug, and new evidence suggests that a virus also attacks the ladybird's brain, paralysing and enslaving it as a zombie babysitter. The larva emerges and weaves a cocoon between the ladybird's legs so the paralysed bug acts as a bodyguard until the larva is ready to leave.

Amazingly, a quarter of ladybirds recover from their zombification!

DID YOU KNOW...

Asperatus clouds are the newest to be identified

Asperatus clouds have been spotted in England, France, Norway and the USA

The last time a new type of cloud was officially recognised by the UN's World Meteorological Organization was in 1951, but these choppy seas in the sky could be next. After being unable to identify the clouds from photos sent in by sky watchers all over the world, the Cloud Appreciation Society has proposed that they should be officially classified as asperatus clouds, inspired by the Latin word for 'roughened'. For this to happen, the cause of the cloud has to be identified first. Although their formation is not yet entirely understood, some experts believe that they form under the same conditions as mammatus clouds, which look as though they have a series of pouches hanging below them. These occur when ice crystals in the clouds sink, but are too large to evaporate in the air below.

To form an asperatus cloud, strong winds then shear the underside of the mammatus cloud to form undulating waves instead of pouches. If they are classified, the clouds will be included in the International Cloud Atlas, which has not been published since 1975.

Mockingbirds don't just mimic other birds

The northern mockingbird is one of 17 mockingbird species

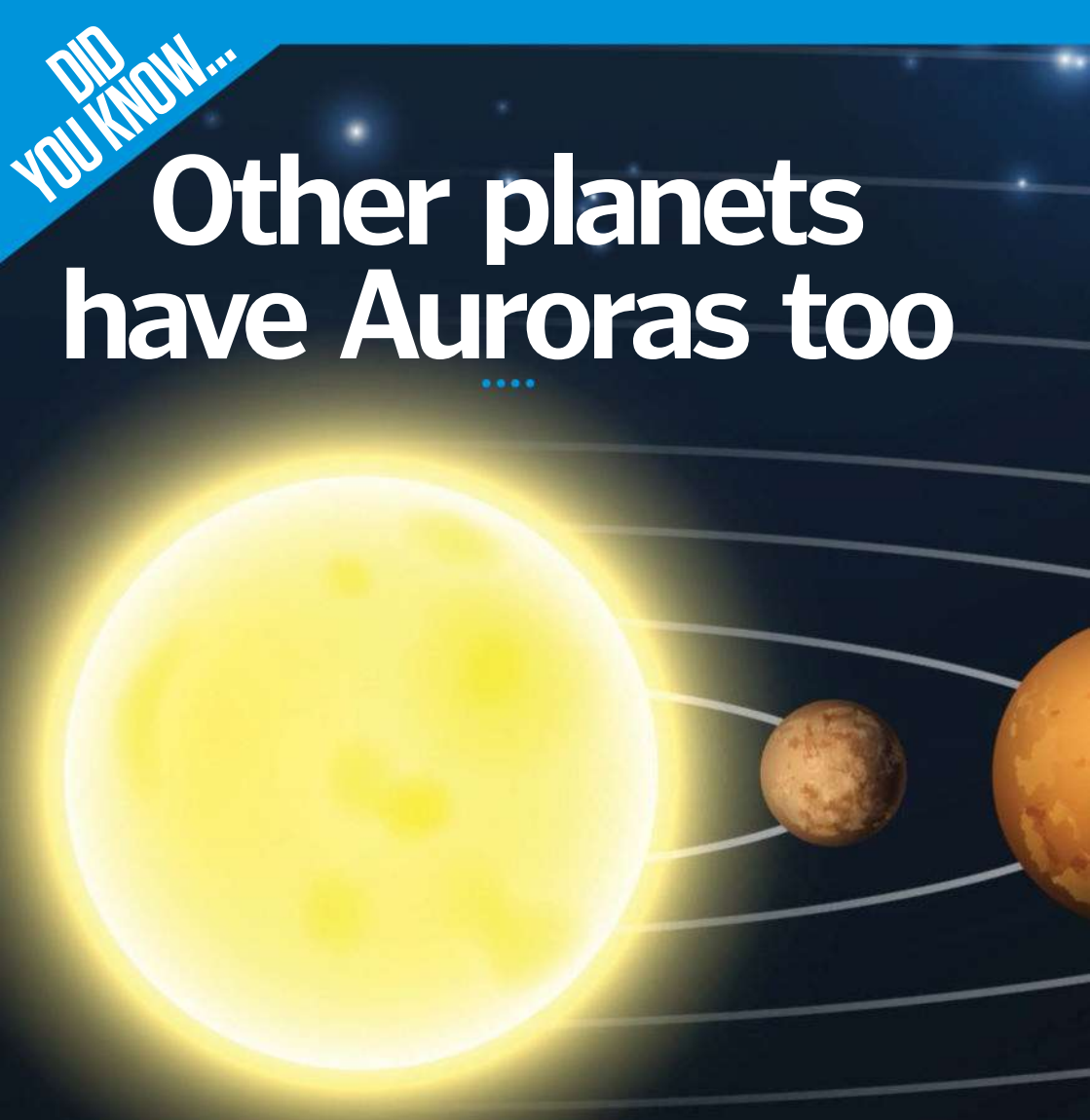
Mockingbirds are masters of mimicry – they've been caught imitating car alarms and bells, as well as other animals. Variations in the singing of males are linked to the hormonal changes necessary to get the reproductive systems ready for mating. If a male mockingbird has a wide repertoire, he conveys to females that he has an established territory and good survival skills.

It takes more energy for the sun to heat water in the air

Deserts contain almost no moisture, meaning the temperature can rise and drop very quickly, although not all deserts are hot. It takes much more energy to heat water than air, so in humid conditions, a lot of the Sun's energy is used to warm the water in the air and the ground. But when the Sun shines on a desert, all of its energy goes into heating the air and the ground itself, allowing them to grow extremely hot. Most deserts cool dramatically overnight as there is not moisture present to retain heat. Many deserts form in subtropical regions, but there are also cold deserts at the poles.

DID YOU KNOW...

Other planets have Auroras too



For many years, the auroras seen on our planet were thought to be the souls of the dead moving to the afterlife. An aurora on Earth is actually caused by the Sun and can be thought of as a form of space weather. Solar winds hit Earth with highly charged particles, but our planet's magnetic field deflects most of them before they reach the atmosphere. Every so often these winds are boosted by solar flares or coronal mass ejections, which release huge amounts of plasma. When these intense solar winds reach Earth, some of the ionised particles get trapped in the magnetic field. These

VENUS

Similar to Mars, Venus does not possess its own planetary magnetic field, but flashes of light from the planet have been identified as auroras. Scientists have found that the same process that causes auroras on Earth can form a gigantic magnetic bubble around Venus, allowing auroras to occur. This is possible due to Venus having a magnetotail, which was formed by ionosphere and solar wind interaction. The fact that magnetic reconnection can occur within Venus' magnetotail suggests auroras are the cause of the light that scientists have observed emitting from this planet.

You can clearly see the difference in the magnetospheres of Venus (top) and Mars (bottom) compared to Earth

MARS

On Mars, auroras appear near areas of magnetised rock within the planet's crust rather than near the poles, when charged solar particles concentrate toward them. This is because it lacks a self-generated magnetic field, possessing only 'crustal magnetic anomalies'. Scientists found that the location of the light emissions corresponded with the location of the strongest magnetic fields found on Mars. It is thought these anomalies are the last traces of Mars's planetary magnetic field, which it displayed at some time in its history. This type of aurora formation is totally unique to Mars as far as scientists are aware.

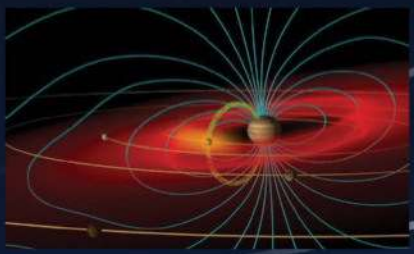
NASA's Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft observing the 'Christmas Lights Aurora' on Mars

particles are then accelerated along the field lines toward the poles where they can enter the upper atmosphere, colliding with gas particles that cause them to emit bright light. This process creates the mesmerising aurora borealis and aurora australis, more commonly known as the northern lights and the southern lights respectively.

On Jupiter, Saturn, Uranus and Neptune, auroras form in a similar manner to how they form on Earth. But on Mars and Venus they form very differently, as neither of these planets possess a significant magnetic field.

JUPITER

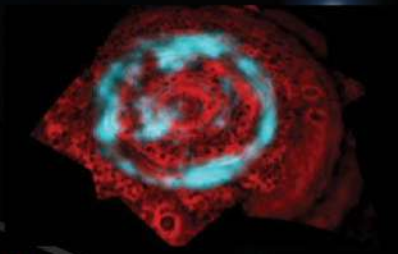
Although some of the auroras found on Jupiter form in a similar manner to those on Earth, many are formed due to the trapping of particles within its own magnetic environment. Unlike Saturn's main aurora that changes size as the solar winds vary, Jupiter's main auroral ring maintains a constant size. This is due to its formation through interactions within its own magnetic environment. Jupiter's moons are also believed to be able to influence auroras. Io, Jupiter's volcanic moon, is thought to produce gases that travel into Jupiter's atmosphere, where they can contribute to the planet's aurora formation.



This shows Jupiter's magnetosphere and how its moons become involved in aurora formation

SATURN

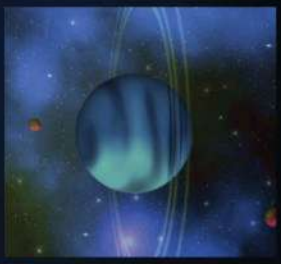
Saturn's auroras differ from Earth's in their size; they can stretch to amazing heights of 1,000 kilometres (621 miles) above Saturn's cloud tops. The charged particles come from the Sun's solar winds blasting past the planet. The particles smash into hydrogen in Saturn's polar atmosphere, ionising the gaseous atoms, which causes photons to be released and leads to the aurora. This planet's auroras are actually not visible to the human eye, due to the fact that the emitted light lies in an infrared and ultraviolet spectrum we can't see. It's thought that as on Jupiter, Saturn's moons may also influence the auroras.



Saturn's auroras occur near the planet's poles, much like they do on Earth

URANUS

The presence of auroras on Uranus was detected in 2011 by Hubble. It is thought this was possible due to heightened solar activity during this period, which increased the amount of charged particles carried in solar winds from the Sun. The auroras formed on this giant ice planet appear far away from the north and south poles, unlike on Earth. This is because of the planet's magnetic field, which is inclined at an angle of 59 degrees to the axis of its spin. These auroras are fainter than their Earth counterparts and last only a couple of minutes, unlike those on our planet, which may last for hours at a time.



Uranus has a mass over 14 and a half times that of Earth's

DID YOU KNOW...

Olympus Mons is almost the same size as France

The biggest mountain in the Solar System is Olympus Mons, a 26-kilometre (16-mile) high shield volcano on the planet Mars. This makes it an incredible two-and-a-half times the size of the tallest mountain on Earth, Mauna Kea, and just under three times the height of Mount Everest. Not only is it tall, Olympus Mons is also incredibly wide, stretching 624 kilometres (388 miles) across its base. This enormous geological feature has been steadily building up longer than life has existed on Earth. As these numbers are pretty tricky to get your head around, we've put together some handy comparisons so you can fully appreciate just how impressive Olympus Mons is.

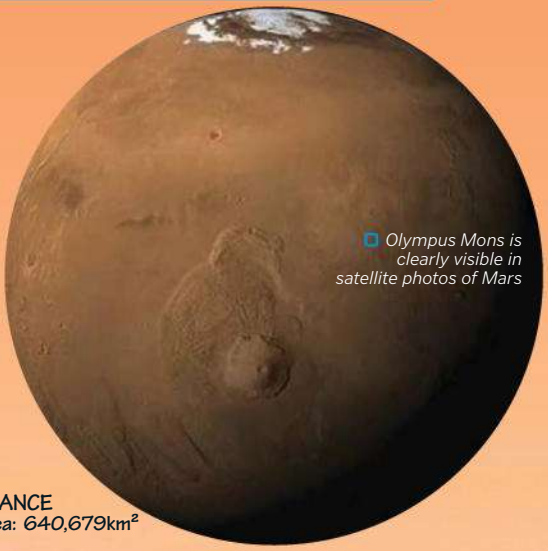
SATURN

Saturn's auroras differ from Earth's in their size; they can stretch to amazing heights of 1,000 kilometres (621 miles) above Saturn's cloud tops. The charged particles come from the Sun's solar winds blasting past the planet. The particles smash into hydrogen in Saturn's polar atmosphere, ionising the gaseous atoms, which causes photons to be released and leads to the aurora. This planet's auroras are actually not visible to the human eye, due to the fact that the emitted light lies in an infrared and ultraviolet spectrum we can't see. It's thought that as on Jupiter, Saturn's moons may also influence the auroras.

MOUNT EVEREST
Height: 8,848m (29,029ft)

HEIGHT

At 26 kilometres (16 miles) high, nothing on planet Earth is even half as high as Olympus Mons. This is because on Earth tectonic plates move, shifting the hot spot and creating volcano chains, such as the Hawaiian islands. Mars doesn't appear to have these, so the hot spot stays in the same place, allowing a single volcano to build up. You would have to stack more than 30 of the world's tallest building, Burj Khalifa, on top of one another to reach its summit. If it were on Earth, it would reach up into the lower stratosphere, the second major layer of the Earth's atmosphere.



Olympus Mons is clearly visible in satellite photos of Mars

WIDTH

The width stretches an amazing 624 kilometres (388 miles) across. This is because it has been growing over billions of years by lava streaming down its sides, solidifying and building up. Eruptions are more frequent on Mars than on Earth because there is less resistance to the upsurge of lava. This provides much more material for it to increase in size. Olympus Mons is part of the Tharsis Montes region, which is a collection of shield volcanoes that have formed on the crustal bulge of Mars. Olympus Mons' average gradient is just five per cent. Its total base diameter is the same as the distance between London and Glasgow or New York and Pittsburgh.

OLYMPUS MONS
Height: 26,000m
(85,300ft)

VOLUME

Even though Olympus Mons may look impressive on the surface, underneath it is just as fascinating. At 4 million cubic kilometres (959,650 cubic miles), the volume of Olympus Mons is 100 times that of Mauna Loa, Earth's biggest volcano. It would hold a staggering 1.6 billion Great Pyramids and 50 times the volume of the Caspian Sea, Earth's largest lake.

CRATERS

As the volcano erupts lava flows out of the magma chambers. This creates a large empty space, which becomes structurally weak. As the lava solidifies and gets heavier the structure collapses in on itself. The resulting crater is called a caldera. Olympus Mons has six, with a depth of about kilometres (1.9 miles) below the summit of the volcano. It is approximately 80 kilometres (50 miles) in diameter and 4,800 square kilometres (1,850 square miles).

FORMATION

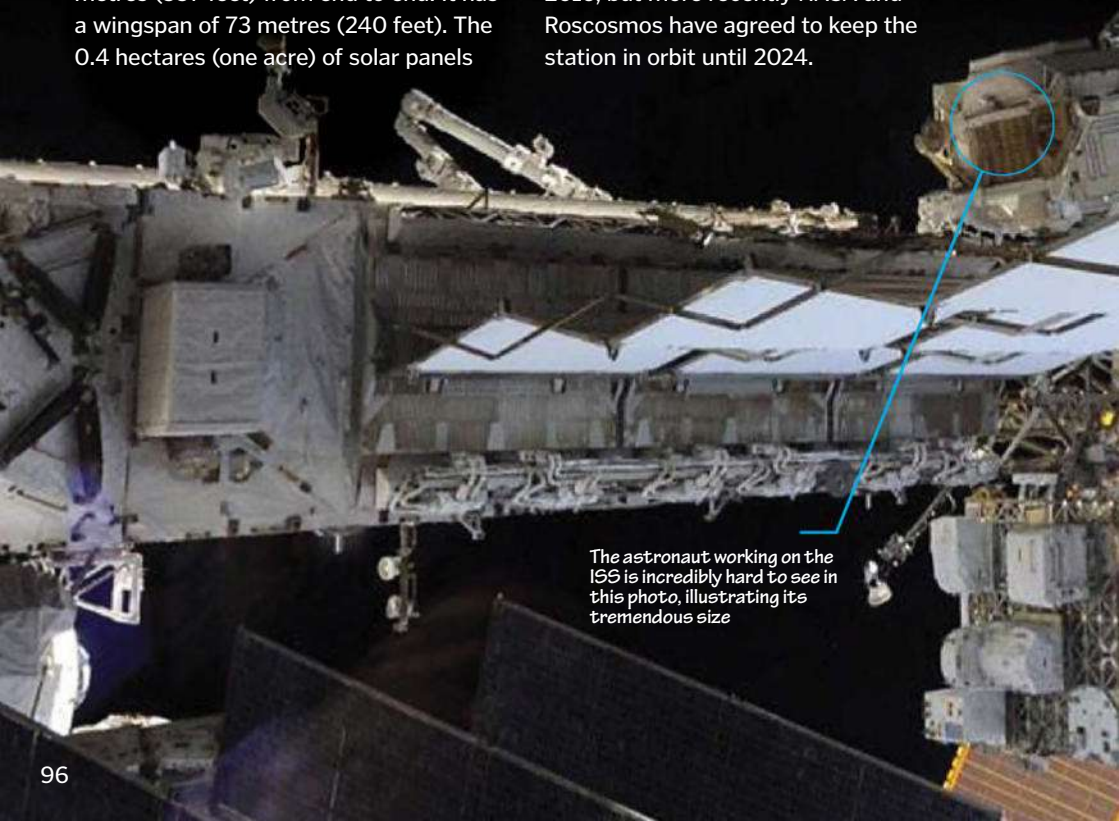
The formation of Olympus Mons has been a long and drawn-out process. Lava built up in the centre of Mars and erupted slowly because the planet's reduced gravity doesn't pull the lava down as quickly as on Earth. This results in a long, shallow volcano. Research has shown that Olympus Mons started its formation around 3.6 billion years ago. This is about the same time that life began on Earth in the form of bacteria and only 1 billion years after the formation of Earth itself.

DID YOU KNOW...

ISS has a mass of 420,000 kilograms

The size of the International Space Station is incomparable to anything else ever launched into space. With a total mass of approximately 420,000 kilograms (925,000 pounds), it resides 400 kilometres (250 miles) above Earth in one of the lowest possible orbits, meaning that it's visible with the naked eye from the ground. It measures 108.8 metres (357 feet) from end to end. It has a wingspan of 73 metres (240 feet). The 0.4 hectares (one acre) of solar panels produce enough electricity to power the equivalent of 40 homes back on Earth. Living space on the ISS is comparable to a six-bedroom house, and is equipped with a gym, two bathrooms and a 360-degree bay window.

At the time of its tenth anniversary back in 2010, the ISS had travelled over 2.4 billion kilometres (1.5 billion miles). The ISS is still our best space laboratory; the research potential related to both life on Earth and in space is still vast, but the future of the ISS has been in danger. A decision had to be made as to whether it was worth keeping a piece of 1990s solar-powered technology that costs billions of dollars every year to operate and maintain. The US had previously considered decommissioning the ISS by 2016, but more recently NASA and Roscosmos have agreed to keep the station in orbit until 2024.

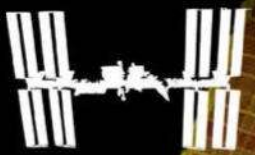


The astronaut working on the ISS is incredibly hard to see in this photo, illustrating its tremendous size

COMPARE THE ISS TO OTHER MAN-MADE CREATIONS

RUSSIAN NAVY TYPHOON SUBMARINE
Length 175m (574ft)

ISS
Length 108.8m (357ft)



BOEING 777-300
Length 74m (242ft)

SPACE SHUTTLE
Height 56m (184ft)

MIR SPACE STATION
Length 31m (102ft)

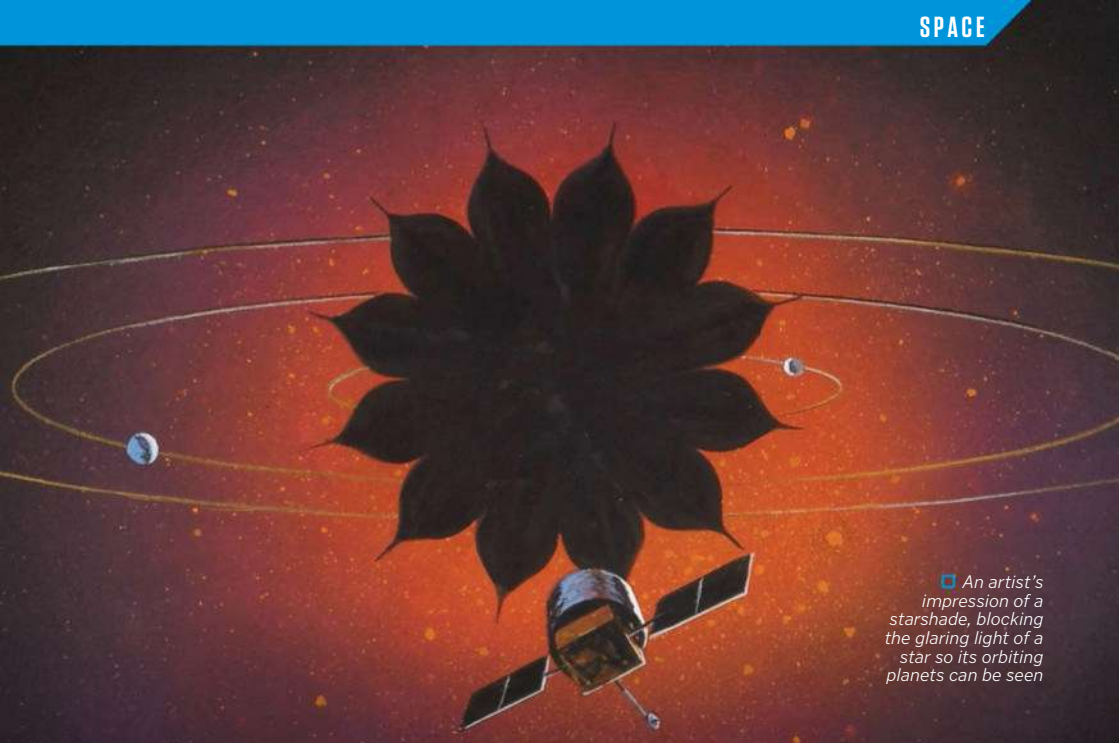
DID YOU KNOW...

It is possible to feel the Earth spinning

The Earth's rotation generates a centrifugal force pulling upward, acting to partially balance out the force of gravity pulling us down. At the equator, you weigh 0.346 per cent less than at the poles. That's a difference of only about 250g (8.8oz). It also causes the Coriolis effect, which deflects the wind in opposite directions in the northern and southern hemispheres. Westerly or southwesterly winds in Britain are due to the Coriolis effect, so you could say you feel the Earth spinning when the wind in your face is from the west or southwest.

The Sun's gravity holds the planets in orbit

The planets were set in motion during the formation of our Solar System and are held in orbit by the Sun's gravity. About 4.6 billion years ago, our Solar System was a huge cloud of dust and gas, rotating as it collapsed. As it spun it flattened out, forming the Sun at its centre and a disc of matter surrounding it. Particles of dust in this disc collided and accumulated to form planets. Without the Sun, these planets would travel off into space in a straight line, but the star's immense gravity curves their paths into orbits.



An artist's impression of a starshade, blocking the glaring light of a star so its orbiting planets can be seen

Starshades are shaped like petals

Astronomers have a problem when it comes to trying to take images of planets around other stars. It is the same as our Sun. To be able to see planets that are very close to their stars, astronomers need a way of blocking the glare of a star's light so that we can see the planets in close attendance.

The tool for this job is called a starshade. It is new technology, but could be flown on a planet-finding space mission in the not-too-distant future. The idea is to have a kind of shade, measuring 34 metres (112 feet) across and floating in space in formation tens of thousands of kilometres ahead of a space telescope. The petal shape means the edge of the shade is not sharp, which means the rays of starlight do not bend as much, so the shadow cast by the shade is darker.

Scientists are conducting tests in the desert, using bright LED lights and prototype shades. If successful, starshades could soon be employed on missions such as the James Webb Space Telescope, which is due to launch in 2018.

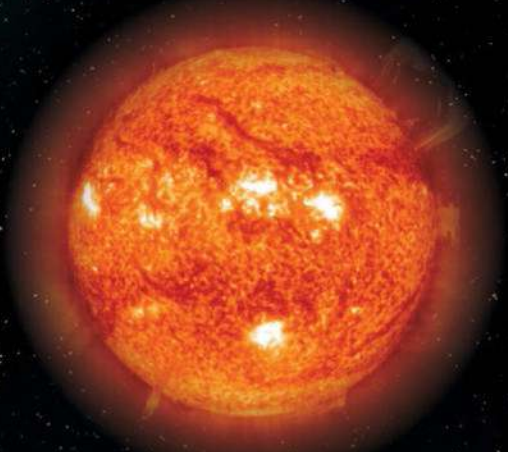
DID YOU KNOW...

We can only see a small part of the spectrum

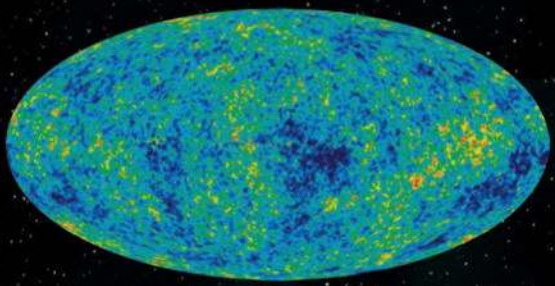
The different types of wave that can be found racing through space can be arranged together in the electromagnetic spectrum. Because of their characteristics, we're able to arrange these waves into an order. The low notes of the electromagnetic spectrum, which contains waves with not a great deal of energy, start at radio and turn progressively to higher notes – through to gamma rays, which are extremely energetic.

Being called 'waves' it's easy to imagine the components of the spectrum as similar to sound waves. With EM radiation, things are different – they don't need air to travel. They are the movement of magnetic and electric fields, so they don't need anything to help them move along. With the advent of a fleet of telescopes in space – such as the Chandra X-ray Observatory – and on the ground, we're able to see the universe in its many wavelengths.

ULTRAVIOLET
If you've ever had sunburn, then you have come into contact with radiation from space known as ultraviolet radiation. It's coming from our Sun, like many of the light waves on this list. Luckily we aren't often exposed to dangerous levels of ultraviolet radiation, since the ozone in the Earth's atmosphere catches the majority of it.



INFRARED
Anything that gives off heat is throwing out infrared radiation – you even emit a small amount from your body. It's also in space, but is invisible to the human eye. We use telescopes, such as Spitzer, which are sensitive to the infrared part of the spectrum, to find out where it's being emitted. These waves are usually detected coming from nebulae, stellar nurseries where stars are born.



MICROWAVES
You are probably most familiar with microwaves, from using them to heat up your food in cooking appliances. Microwaves can be found throughout the universe – most notably in the Cosmic Microwave Background Radiation, left over from just after the Big Bang, which permeates the universe today and is a chilly -270°C (-454°F).

Missions such as the Chandra X-ray Observatory are showing us the universe in different wavelengths

X-RAYS

X-rays are made when matter is heated to millions of degrees where magnetic fields, great forces and immense gravity have a strong influence. It is this radiation that helps us to learn more about black holes, neutron stars, dark energy and dark matter.

VISIBLE

Visible light is the light we humans can see. It's because of this part of the electromagnetic spectrum that the human eye is able to detect the observable universe – that's the stars, planets and galaxies; we're able to see without the need for infrared, gamma ray or X-ray telescopes.

GAMMA RAYS

Gamma rays are so harmful to us that they can penetrate straight through the human body and can only really be stopped by several centimetres of lead. On Earth, gamma rays can be made in nuclear explosions, but in the universe, they are associated with great explosions in distant galaxies. These are known as gamma-ray bursts and are among the most energetic objects in the cosmos.

RADIO WAVES

We use radio waves for communication and broadcasting, but they also occur naturally, emitted by lightning and objects in space such as galaxies, pulsars and quasars. These waves were first predicted by physicist James Clerk Maxwell and later discovered to be coming from our galaxy in the 1930s by physicist and engineer Karl Jansky.

DID YOU KNOW...

There are ants in space

The ants' movements are recorded using a video camera for review and comparison with similar experiments

© NASA

Several hundred ants are currently in orbit on the International Space Station, in an experiment to see how they adapt to microgravity environments. The way ant colonies work is fascinating. They don't have a central control; no single ant can force another to do something. Instead, they use information gathered locally to assess situations, which means the behaviour of the colony depends on the local cues each ant produces. Colonies send out worker ants to search and assess new areas. This can help them find food, map foreign terrain and identify potential threats.

By studying the ways ants assess an alien environment, scientists believe they will be able to develop better search algorithms for robots. They want to create autonomous search robots that do not need a central control, much like ant colonies. These would then be more effective at tasks such as finding survivors immediately after a disaster takes place. This research could also impact mobile phone networks, helping to solve problems of interference.

GREENHOUSE EFFECT
The reason Venus is so hot is its atmosphere, 96.5 per cent of which is composed of carbon dioxide, which is a deadly greenhouse gas

ACIDIC ATMOSPHERE
Lacing the atmosphere are clouds of sulphuric acid. On Venus, the acid rain is enough to kill you

Venus is the deadliest planet

SUFFOCATION
With all the carbon dioxide and sulphur, there is no room for oxygen to breathe

VOLCANIC WORLD
There are more than 1,600 volcanoes covering the surface of Venus, with evidence that some of them have violently erupted in the recent past

HOTTER THAN HELL
Venus is the hottest planet in the Solar System, with scorching temperatures of 460 degrees Celsius (860 degrees Fahrenheit) – hot enough to melt lead

CRUSHING PRESSURE
The pressure of the air at the surface is 92 times greater than on Earth. Space probes that have landed on Venus have been literally crushed

DEHYDRATION
Venus is bone dry - almost all its water molecules have escaped into space, or been split apart in the upper atmosphere

DID YOU KNOW...

Twins are helping NASA prepare for a space mission

On 27 March 2015, astronaut Scott Kelly voluntarily voyaged into space on a unique one-year mission for NASA. His identical twin brother Mark, a retired astronaut, is also integral to the study, although his feet will remain firmly on planet Earth. This unprecedented experiment offers scientists a rare opportunity to study the effects long-term spaceflight has on the human body, which is vital if NASA hopes to one day send astronauts on a mission to Mars.

The fact that the brothers are identical twins is crucial to the investigation, as they share virtually the same DNA. This means scientists will be able to compare any physiological and mental changes that occur between them during the experiment. Prior to Scott's arrival at the ISS, NASA researchers collected genomic, physiological, molecular and other data from each twin, something that will continue to be reviewed and compared both during the mission and after Scott has returned to Earth.

Biological samples are expected to uncover more evidence on the physiological effects, as the investigation will look closely at how environmental stressors, such as microgravity, radiation and confinement, affect the muscles, heart and brain. Behavioural changes will also be compared and documented, in order to better understand how the likes of reasoning, perception and decision-making are also affected.

Identical twins share the same DNA code as they come from the same fertilised egg

PHYSIOLOGICAL EFFECTS OF SPACE

Space travel can have a dramatic physiological effect on the human body. Reduced gravity, even over a short period of time, can be detrimental.

On Earth, our bodies are constantly working against gravity and this helps to keep our muscles and bones strong, so without it they will effectively start to weaken, this is the opposite in space.

Bone and muscle loss is a common side effect of microgravity, as it makes physical activities less demanding. The reduced workload on your muscles and bones makes your body think those cells are no longer required, so over time they will waste away.

Astronauts also grow a few centimetres in height while in space because the spine stretches and lengthens without gravity pushing it down. This in turn can lead to back aches. Astronauts typically suffer from headaches, nausea and swelling while their bodies adapt to their new environment.

Microgravity can have an adverse affect on the human body and cause astronauts to suffer from bone and muscle loss in space

DID YOU KNOW...

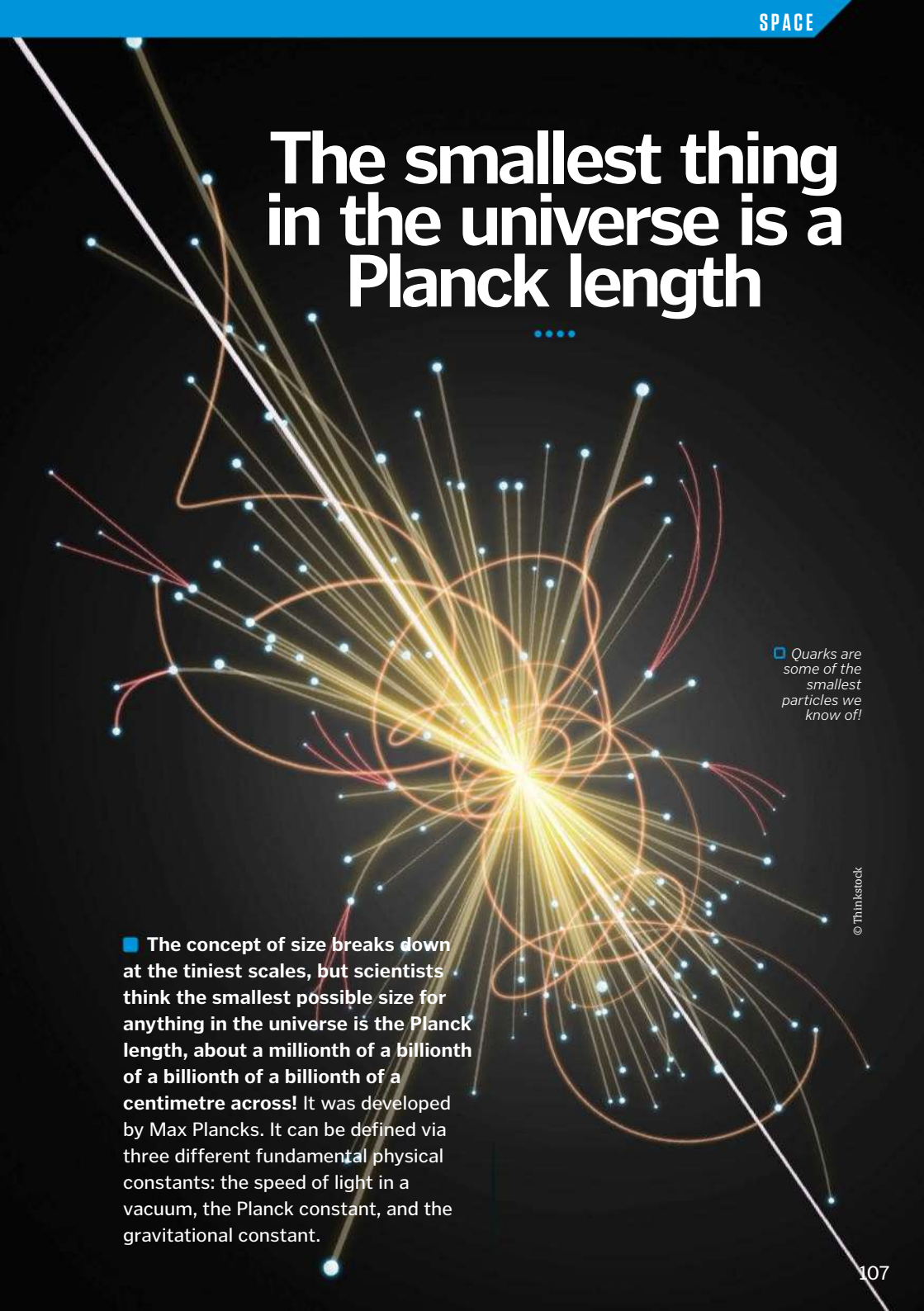
This on-screen view from OnSight shows how mission scientists can 'meet up' to discuss operations

The HoloLens will help conduct work in space

With the chance to walk on Mars still many years away, Microsoft and NASA have worked together to provide scientists with the next best thing. Using the Microsoft HoloLens headset, new OnSight software will use data gathered by the Curiosity rover to simulate Mars' environment, enabling scientists to explore as if they were standing side by side with the rover. Scientists have used pictures to navigate Mars before, by converting them into 3D stereo views. The problem with this had been that scientists struggled to recognise how far away objects were, as depth of vision is very difficult to show.

The OnSight system works using holographic computing, which blends a view of the physical world with imagery created by computer, producing a mix of virtual and real surroundings for the user. Scientists can walk around the planet's surface, bend down to closely examine a rock, and even direct the rover to take high-resolution images of interesting areas.

The smallest thing in the universe is a Planck length



Quarks are some of the smallest particles we know of!

The concept of size breaks down at the tiniest scales, but scientists think the smallest possible size for anything in the universe is the Planck length, about a millionth of a billionth of a billionth of a billionth of a centimetre across! It was developed by Max Plancks. It can be defined via three different fundamental physical constants: the speed of light in a vacuum, the Planck constant, and the gravitational constant.

DID YOU KNOW...

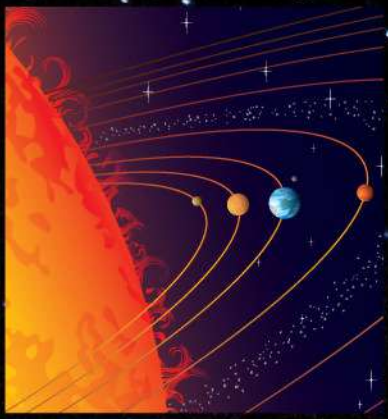
There is a Y shape on Venus

Venus's famous Y-shape pattern was first seen in 1974, when Nasa's Mariner 10 spacecraft was sent to observe both Venus and Mercury. The Y spans almost the whole planet; the Y's arms are more than 17,000 kilometres (10,500 miles) long and the stem is around 19,200 kilometres (11,900 miles) in length. Venus's winds are incredibly strong, capable of moving the upper part of the atmosphere at up to 400 kilometres (250 miles) per hour. These winds circle the planet roughly every five Earth days. However, Venus takes around 243 Earth days to complete a full rotation – moving less than seven kilometres (four miles) per hour at the equator – so the wind speed is much quicker than the planet's own spin. The rate at which these winds circle the planet changes due to the varying circumference of Venus at different latitudes. For example, at the north and south poles, the winds circle the planet at a much quicker rate. The difference in this rate is the cause of the formation of the Y shape, as the clouds at the top and bottom of the Y complete their circular trip around the planet quicker, giving rise to the arms of the letter 'Y'. Scientists believe it was crucial to find out the origins of this pattern, as this helps their understanding of why the planet's atmosphere rotates 60 times faster than its surface.

Venus is so bright that it can be seen during the day, particularly when the Sun is low on the horizon

BACKWARD PLANET

One of the most intriguing qualities of Venus is that it rotates backward, known as a 'retrograde' rotation. It is the only planet in the Solar System to do this; if you were to stand on Venus you would see a sunrise in the west and have to wait just shy of 117 days before seeing it set in the east. The reason for this bizarre fact is still hotly debated; one theory that has been put forward is that another planetary body similar in size to Venus collided with it at some point in history. After the forces from this collision had evened themselves out, Venus was left with its current rotational speed and direction. Without knowing this planet's history in detail, it is hard to apply weight to any of the theories out there.



Venus is actually hotter than Mercury, despite being further from the Sun, as its atmosphere traps more heat

THE WEATHER

Although Venus is sometimes referred to as Earth's twin due to their comparable sizes, their atmospheres differ vastly. The average temperature on Venus is a rather hot 460 degrees Celsius (860 degrees Fahrenheit), making it unlikely for life as we know it to exist. When you also consider that its atmosphere is a toxic mix containing carbon dioxide and nitrogen with clouds of sulphuric acid and the surface pressure is 90 times that of Earth, it seems unlikely for any weather to occur. In spite of this, NASA has confirmed there is lightning on Venus, potentially even more than there is on Earth. Future missions to the planet will have to take into account potential interference from lightning strikes.

DID YOU KNOW...

Once the battering ram hit, the right to surrender was lost

Through centuries of campaigns, the Roman military drove the expansion of their Republic and later their Empire, dominating vast swathes of Europe, North Africa and the Middle East. They forged their formidable reputation thanks to a well-trained army and cutting-edge technology, as well as their ingenious tactics and engineering.

When it came to breaking down the walls to capture towns and forts – castles as we know them hadn't yet been invented – the Romans put all these things to the test, improving war machines invented by the Ancient Greeks and

TYPES OF SIEGE MACHINES

SCORPION
Like a giant crossbow, the scorpion could fire an iron bolt up to 400m (1,312ft) with terrifying accuracy.

ONAGER
Taking its name from the kick of a wild ass, this catapult could fling both rocks and clay pots filled with burning pitch.

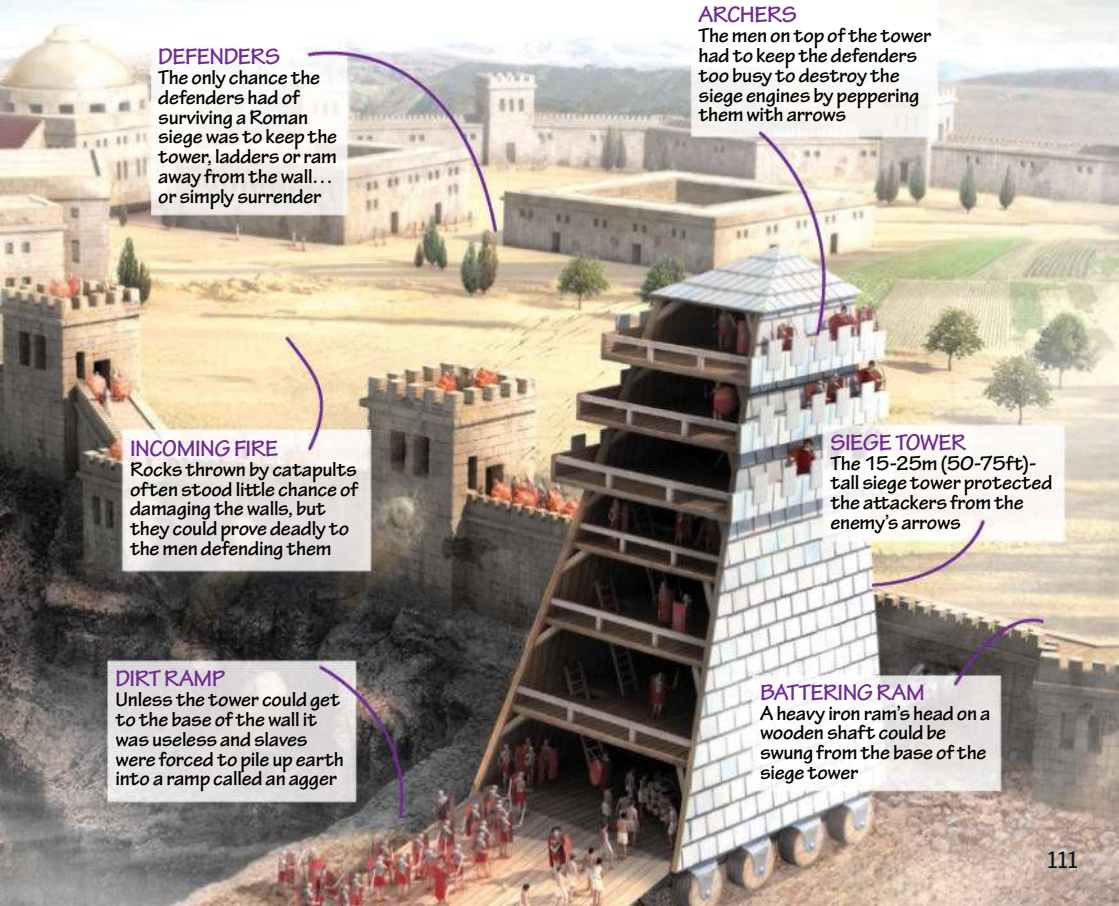
BALLISTA
Similar to the scorpion, the largest ballistas had a range of up to 1,100m (3,609ft).

creating some of their own. The siege would first begin with the Romans setting up a camp with guard towers and fortifications of their own to cut off the enemy from reinforcements and food. The Romans would also try to cut off their foe's water supply by digging new channels to redirect rivers or by digging down to divert the flow of underground springs.

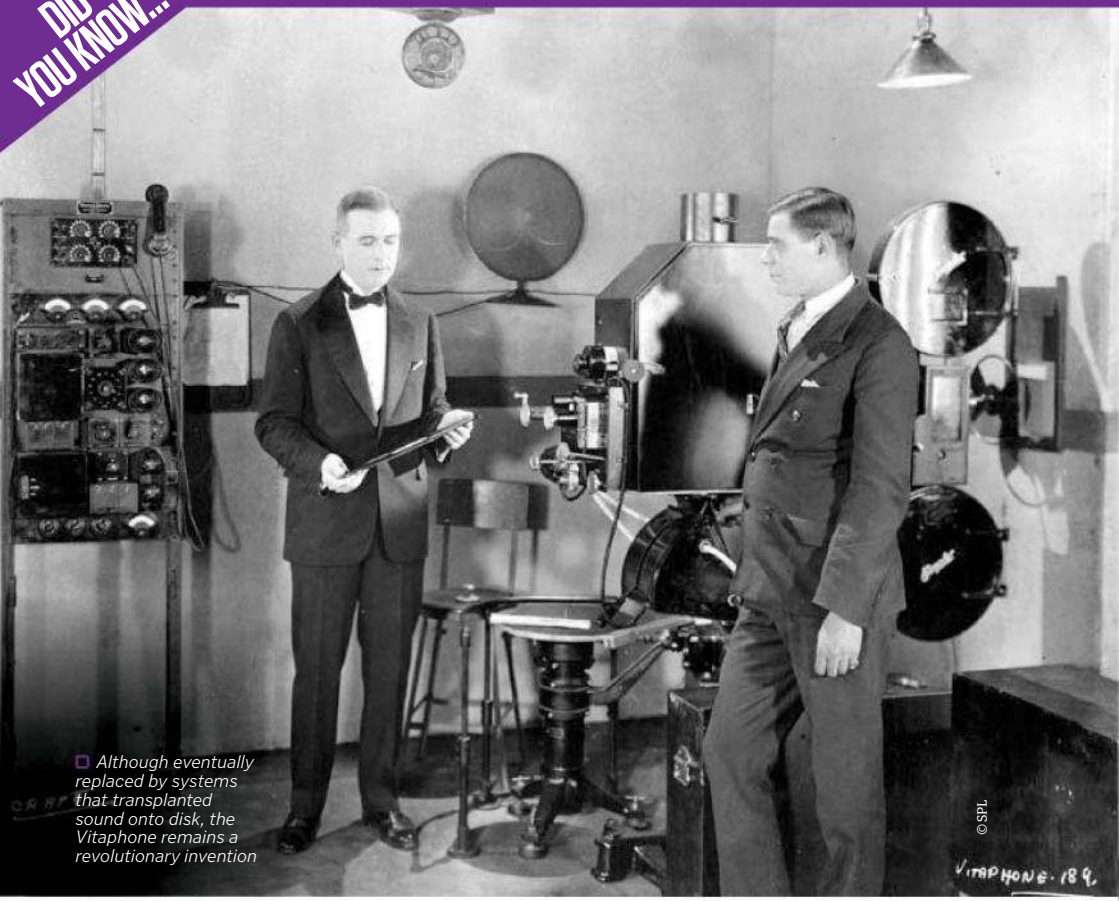
If hunger, thirst and despair didn't force the enemy to surrender, the Romans would then attack with various siege engines, such as wheeled towers that enabled men to storm directly over the defences across bridges. Battering rams and grappling hooks would knock or pull down walls, and catapults and ballistas would hurl rocks or iron bolts at the defenders.

Engineering played a role too, as tunnels were sometimes dug under the walls, causing the foundations to collapse and bringing the wall crashing down with them.

Once the target had been taken, survivors were often killed, taken as slaves or had their right hands cut off so that they couldn't use weapons. Under Roman law, as soon as the battering ram touched the wall the defenders lost all right to surrender. Can you blame any that gave up as soon as the Romans arrived?



DID YOU KNOW...



Although eventually replaced by systems that transplanted sound onto disk, the Vitaphone remains a revolutionary invention

The first film with audible dialogue was The Jazz Singer

Films have long represented a popular form of entertainment, but for much of the early-20th century, they were restricted to the silent format. Soon, however, this would all change.

Inspired by Thomas Edison's phonograph and Lee de Forest's Audion tube, the Vitaphone was created by Western Electric, and in turn was bought and developed further by Warner Bros. The Vitaphone comprised a film projector rigged up to a record player, with the sound being played over the footage of the film. In turn, the sound was amplified so that it was more audible to the audience, with a projectionist on hand to make sure the footage and sound were in sync.

The first sound movie to use the Vitaphone system was Don Juan on 6 August 1926 – although since there was no dialogue, the honour of the first 'talkie' is credited to The Jazz Singer, which was released on 6 October 1927.

The ‘Butcher crocodile’ was king before dinosaurs

A 3D model of the creature was created from scans of its fossils

When the supercontinent Pangaea was breaking apart, 2.7-metre (nine-foot) tall, sharp-toothed creatures roamed the area that would become North Carolina in North America. Palaeontologists have recently discovered parts of the skeleton belonging to Carnufex carolinensis, an ancestor of today’s crocodiles. Nicknamed the ‘Carolina Butcher’, it is believed to have used its blade-like teeth to slice flesh from its prey, likely to have been armoured reptiles and the early relatives of large mammals. As its forearms were so short, it is also suspected the creature walked on two legs, much like a T-rex.

“As its forearms were so short, it is also suspected the creature walked on two legs, much like a T-rex”

DID YOU KNOW...

The Sainte-Chapelle only took around seven years to build

The Sainte-Chapelle, or 'Holy Chapel', was commissioned by King Louis IX of France more than 770 years ago. The reason? To house his most prized possessions – what was believed to be the authentic 'crown of thorns' worn by Christ at his crucifixion, and fragments of the Holy Cross. The king did not want these relics to become lost, so he decided to buy them and build an appropriately elaborate church to display them in.

It is a truly stunning example of medieval architecture; nothing like this had ever been constructed before in history. The fact it was built between around 1241 and 1248 is even more incredible considering the Notre Dame took more than 200 years to build from 1163. The church walls act essentially as window frames for the 15 immense stained glass panels. The stained glass mainly depicts famous Bible stories, including parts from the Old Testament such as Genesis and Exodus. Also shown is the history of the holy relics, from their discovery by Saint Helen to their eventual arrival in the French Kingdom. Restorations of the stained glass in the 19th century remained faithful to the original designs, and further work is underway today in order to protect the glass from deterioration for years to come.

When you think of medieval architecture, you may automatically think of dark, dingy buildings. The Sainte-Chapelle defies this preconception, with a majestic design that shows off the power of light, embracing it to create a truly breathtaking church.

PRODUCING STAINED GLASS

The soaring stained glass windows are Sainte-Chapelle's trademark

Making stained glass to a high standard is much easier now than it would have been during the Sainte-Chapelle's construction in the 13th century. Throughout this period, glass factories were located in areas with a good supply of silica such as sand, an essential ingredient for the mix. The overall process was much the same then as it is today; first you mix the silica, potash and lime along with a metallic oxide, which provides the colour. This could be copper oxide, which can produce blue, green or ruby colours depending on the conditions. These ingredients are then heated in a furnace to around 1,371 degrees Celsius (2,500 degrees Fahrenheit), creating molten glass. This stage was problematic in medieval times, as creating this heat with the techniques available was a lengthy process and hard to maintain. The glass can then be rolled into thin sheets and left to cool before cutting to the desired size.

ENGINEERING breakthrough
The thin walls between each glass panel were able to support the considerable weight by directing it toward their base

CHURCH SPIRE
This has been replaced on numerous occasions; one spire was destroyed during the French Revolution

ROSE WINDOW
The inclusion of this window is characteristic of Gothic architecture, seen in many cathedrals of this age in northern France

STAINED GLASS
Each window group has four lancets, with three rose windows above them

LOWER CHAPEL
This functioned as the parish church, serving everyone who resided in the royal palace

STAINED GLASS PRESERVATION
Recently, an innovative layer of protective glass has been applied to many of the stained glass windows

DID YOU KNOW...

Quills have been in use for over 1,300 years

Before the invention of the pen, most people used quills to write with. These were stripped bird feathers, usually from geese. Swan feathers were very sought after but geese, crow, owl and turkey feathers were more simpler to obtain.

Quills were easy to supply, comfortable to hold and tapered down to a point so the writer could create all the subtle curves and lines of fine handwriting.

The first record of their use was around the 6th century by European monks, replacing the reeds they had been using up until then. Feathers were stripped, buried in hot sand to harden, hollowed out and then filled with ink. They were time-consuming to make and had to be refilled and reshaped regularly, but continued to be the main writing implement until the metal pen became popular in the mid-19th century.

HOW TO MAKE A QUILL

PRIME YOUR FEATHER

Scout around near a river or lake for a feather that has been dropped by a swan or goose. Ideally it should be around 15cm (6in) long and intact. Using a Stanley knife, very carefully shave off the fluffy feathers at the pointy end. You should be able to grip the quill without touching any feathers. Then place the feather in a bowl of water and leave it overnight to soak.

TOUGHEN AND SHAPE

Heat sand in the oven at 175°C (350°F) and bury the feather, using oven gloves to avoid burns. Wait until the sand has cooled and remove the hardened feather. From about 2.5cm (1in) above the tip, slice down at an angle of around 45 degrees to the tip of the feather. Make a small, flat cut on the opposite side of the tip. There should now be two spikes on the tip that you need to pinch together.

FINISHING OFF

Shave the pinched end so it is nice and smooth and you should have a feather tapering nicely to a point. Dip your quill in the ink where it should soak up the writing fluid. There should be enough to write a fair few lines, depending on how tightly you've pinched it together. The tighter you've pinched it, the more ink it should retain. Take it out and begin writing like a medieval scribe!

The West's demand for collecting shrunken heads in the early-20th century caused tribes to increase their kill rate

Amazonian tribesmen shrunk the skulls of their enemies

Shrunken heads are a somewhat alien concept to modern society, yet it is believed they were still being produced during much of the 20th century. The only recorded examples of head shrinking are in South America by Jivaroan tribes in Peru and Ecuador.

Tribesmen shrunk people's decapitated heads due to their belief of a vengeful spirit, or muisak, inhabiting the body. To stop this spirit and to gain power over the victim's soul, the hunters removed their enemies' heads and shrank them.

First, the warriors would remove the skin and hair from the skull, and seal the eyes and lips shut with pegs. The head skin would then be boiled for half an hour, shrinking it to around a third its original size. The eyes and lips were then sealed more tightly by being sewn shut with woven fibre. By filling the head with hot stones and sand through the hole at the base of the neck, it was possible to shrink it even further until the desired size was achieved. The finished product was typically worn around the warrior's neck, signifying victory in battle.

DID YOU KNOW...

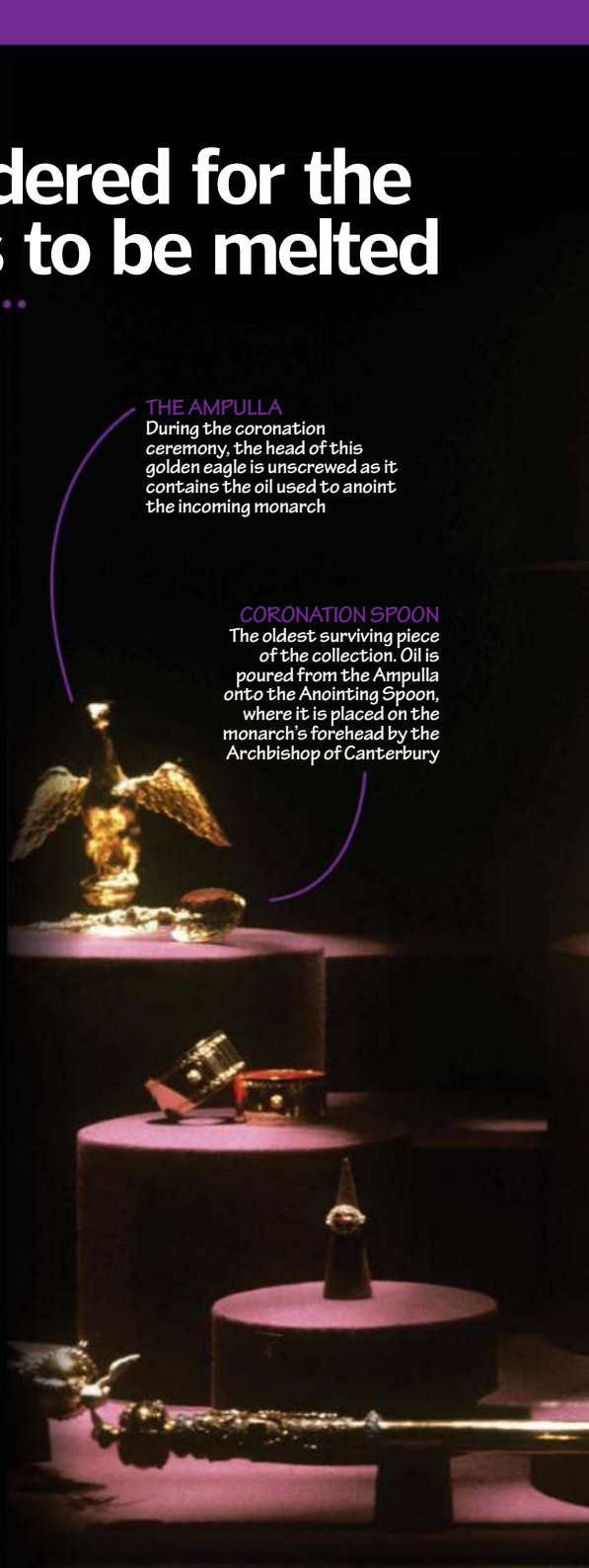
Cromwell ordered for the Crown Jewels to be melted

Along with Buckingham Palace, one of the most famous things about the British monarchy is the incredible collection of crowns, orbs, sceptres and precious stones that makes up what's collectively called the Crown Jewels.

Stored in the Jewel House of the Tower of London since the beginning of the 14th century, the collection has been a symbol of the monarchy ever since the coronation of Edward the Confessor in 1042. It was for this reason that many valuable pieces were lost as Lord Protector Oliver Cromwell ordered the Crown Jewels to be melted. As they represented the monarchy's wealth and power, gold items were melted down and jewels sold. The only items that remained were the Anointing Spoon and three ceremonial swords – the Swords of Temporal Justice, Spiritual Justice and Mercy.

The collection was rebuilt in 1660 after Charles II regained the throne. He commissioned replicas of the destroyed pieces at a cost of £13,000, which today would be around £1.7 million ($2.8 million).

The Crown Jewels do have a practical purpose, though, as they form the regalia that accompanies every coronation ceremony. The crown that was used for Queen Elizabeth II's coronation is St Edward's Crown. The jewel-encrusted golden headpiece weighs a hefty 2.23 kilograms (4.92 pounds), or about the same as a medium-sized rabbit.



THE AMPULLA
During the coronation ceremony, the head of this golden eagle is unscrewed as it contains the oil used to anoint the incoming monarch

CORONATION SPOON
The oldest surviving piece of the collection. Oil is poured from the Ampulla onto the Anointing Spoon, where it is placed on the monarch's forehead by the Archbishop of Canterbury

Queen Elizabeth II wearing St Edward's Crown at her coronation

ST EDWARD'S CROWN
This gold crown is inlaid with sapphires, topazes, citrines, tourmalines and amethysts. It is the crown used at the monarch's coronation

IMPERIAL STATE CROWN
Every time the monarch opens Parliament, this crown is the one they wear. It contains an incredible 3,000 gems including the Second Star of Africa

THE SOVEREIGN'S ORB
The other item handed to the monarch during their coronation. A hollow gold sphere featuring sapphires, rubies and emeralds, while the cross on top of it is inlaid with diamonds. It represents power and Christianity

ALTAR SET
Part of Charles II's extravagant rebuilding included a full altar set, including a golden chalice and a plate used for communion

THE ARMILLS
These gold and enamel bracelets are lined with velvet and worn by the monarch, and are thought to represent wisdom

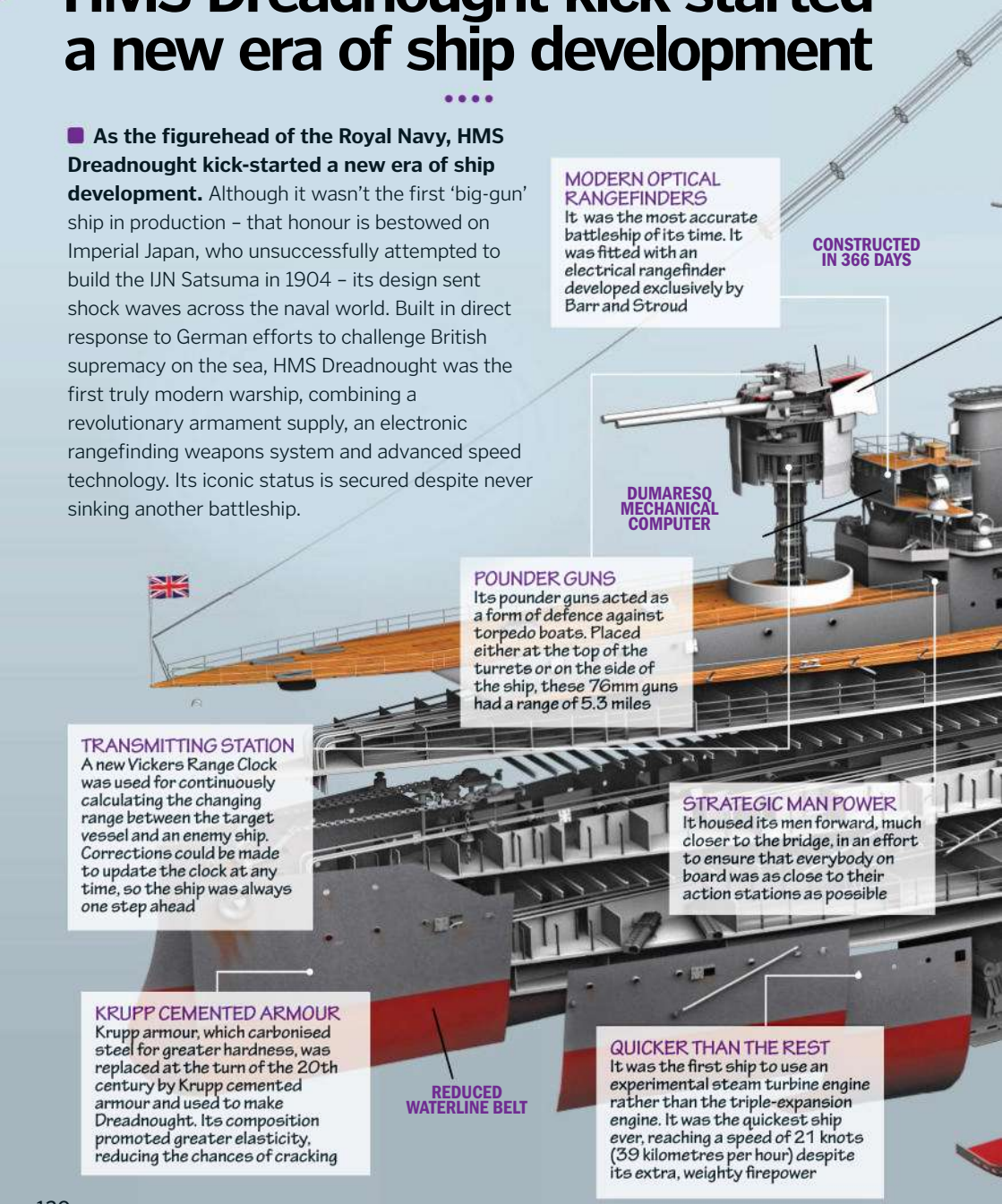
SPURS
No longer worn by the monarch, the spurs are made from gold, velvet and gold thread and were first used for the coronation of Richard the Lionheart

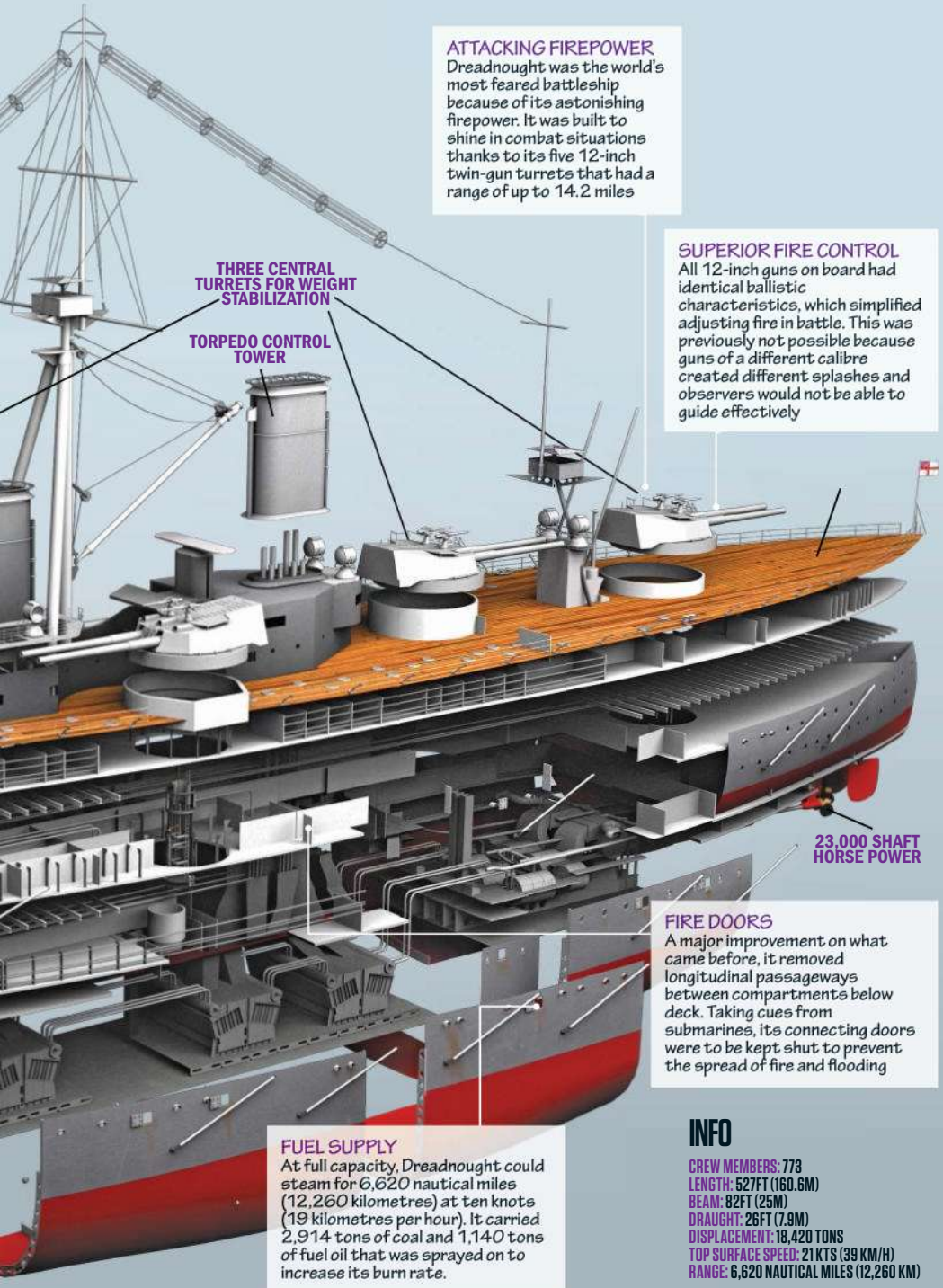
THE SOVEREIGN'S SCEPTRE
Topped with the 530.2-carat Star of Africa, the Sovereign's Sceptre is handed to the new monarch at their coronation. It represents the sovereign's good governance and temporal power

DID YOU KNOW...

HMS Dreadnought kick-started a new era of ship development

As the figurehead of the Royal Navy, HMS Dreadnought kick-started a new era of ship development. Although it wasn't the first 'big-gun' ship in production – that honour is bestowed on Imperial Japan, who unsuccessfully attempted to build the IJN Satsuma in 1904 – its design sent shock waves across the naval world. Built in direct response to German efforts to challenge British supremacy on the sea, HMS Dreadnought was the first truly modern warship, combining a revolutionary armament supply, an electronic rangefinding weapons system and advanced speed technology. Its iconic status is secured despite never sinking another battleship.





ATTACKING FIREPOWER

Dreadnought was the world's most feared battleship because of its astonishing firepower. It was built to shine in combat situations thanks to its five 12-inch twin-gun turrets that had a range of up to 14.2 miles

SUPERIOR FIRE CONTROL

All 12-inch guns on board had identical ballistic characteristics, which simplified adjusting fire in battle. This was previously not possible because guns of a different calibre created different splashes and observers would not be able to guide effectively

FIRE DOORS

A major improvement on what came before, it removed longitudinal passageways between compartments below deck. Taking cues from submarines, its connecting doors were to be kept shut to prevent the spread of fire and flooding

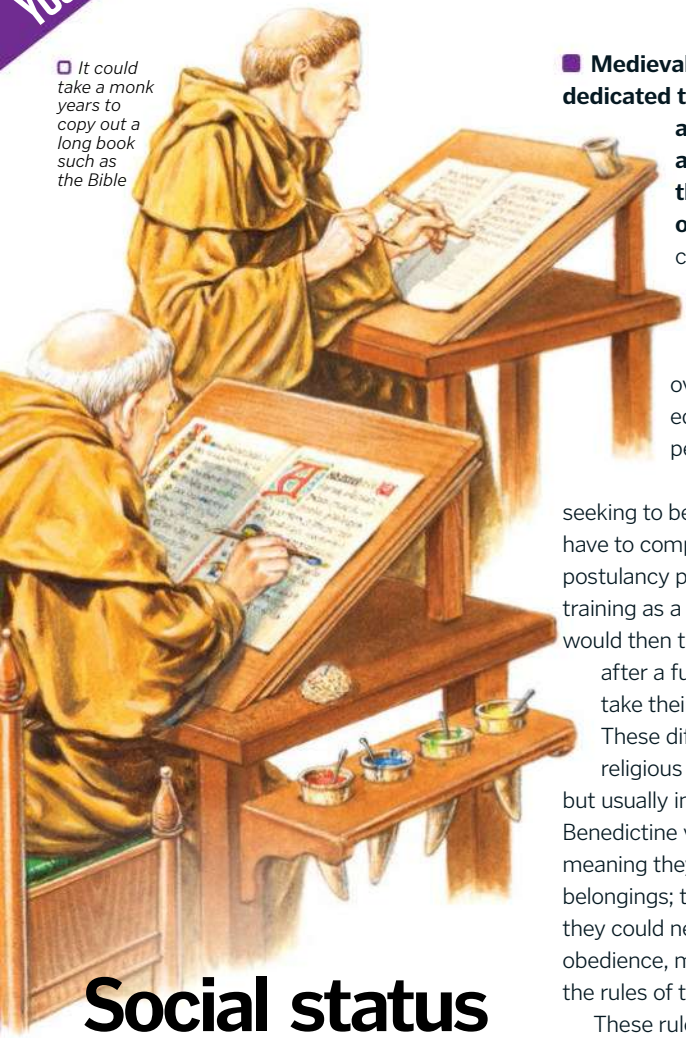
FUEL SUPPLY

At full capacity, Dreadnought could steam for 6,620 nautical miles (12,260 kilometres) at ten knots (19 kilometres per hour). It carried 2,914 tons of coal and 1,140 tons of fuel oil that was sprayed on to increase its burn rate.

INFO

CREW MEMBERS: 773
LENGTH: 527FT (160.6M)
BEAM: 82FT (25M)
DRAUGHT: 26FT (7.9M)
DISPLACEMENT: 18,420 TONS
TOP SURFACE SPEED: 21 KTS (39 KM/H)
RANGE: 6,620 NAUTICAL MILES (12,260 KM)

DID YOU KNOW...



It could take a monk years to copy out a long book such as the Bible

Social status didn't dictate whether or not you could become a monk

Medieval monks were men who dedicated their lives to serving God and their local community, and would live most of their lives within the walls of a monastery. Any man could become a monk, no matter what their social status, and some parents would even hand their child over to a monastery to be educated and bought up to perform religious duties.

However, an adult actively seeking to become a monk would first have to complete a one-month postulancy period before receiving training as a novice for one year. They would then take their simple vows, and after a further four years of service, take their final, or solemn, vows. These differed depending on which religious order the monk belonged to, but usually included the three Benedictine vows: the vow of poverty, meaning they had to give up all their belongings; the vow of chastity, meaning they could never marry; and the vow of obedience, meaning they had to follow the rules of the monastery.

These rules were made by the abbot, the monk in charge of the monastery, and involved a strict routine of work and prayer. Each monastery was also seen as an important part of the local community, as the monks would provide medical care for the sick and hospitality for travellers and the poor. In return, local families would pay one tenth of their yearly earnings to the Church, known as tithes, meaning some monasteries became incredibly wealthy.

LIFE AS A MONK

The daily life of a monk centred around prayer. The main prayer book used was the Book of Hours, which was divided into eight sections, intended to be read at specific times of day. When they weren't praying, the monks were required to carry out manual labour and chores to aid the running of the monastery. Their work depended on their personal interests and skills but could include farming the surrounding land, making wine, cooking the food, washing the clothes, copying manuscripts to preserve them for future generations and educating novice monks.

HAIRSTYLE
To show their commitment to the Church, monks had their scalp shaved, leaving a small strip of hair around the head in a practice known as tonsure

SCAPULAR
Over the tunic they wore a scapular, a piece of woollen cloth with a built-in hood, or cowl

HAIR SHIRT
Some monks would impose suffering on themselves by wearing itchy shirts made of hair underneath their clothes

DAY TO NIGHT
Monks would sleep in their tunics, only removing them for washing, but the scapular was only worn for work and prayer

TUNIC
Each monk was given a floor-length tunic made of wool, which they would tie around their waist with rope

CLOTHING COLOUR
The colour of a monk's clothes indicated the religious order he belonged too. For example, Benedictine monks wore black, while the Carmelites wore brown

FOOTWEAR
Most monks wore shoes or sandals, but some would go barefoot to show sorrow for their sins

A STRICT SCHEDULE

4:30	Get up
5:00	Lauds prayer service
6:00	Prime prayer service
6:30	Breakfast
9:00	Terce prayer service
9:30	Work
12:00	Sext prayer service
13:00	Midday meal
13:30	Private reading & prayer
15:00	Nones prayer service
15:30	Work
17:00	Vespers prayer service
18:00	Compline prayer service
18:30	Bed time
02:00	Matins prayer service

DID YOU KNOW...

A mechanical 20th century pencil sharpener, with gearing and teeth

The sharpener is a French invention

Although the exact origins of the pencil are uncertain, its growing popularity demanded a far less time-consuming and far more precise method of sharpening it than to slash away with a knife.

The first attempt came in 1828 from French mathematician Bernard Lassimone, who placed two blades at 90 degree angles on a block of wood, but this method of grinding down the pencil to a point wasn't any faster than the traditional method.

The mechanism we're familiar with today came in 1847 from another Frenchman, Therry des Estwaux, who invented a cone-shaped device with a single blade that when turned would neatly and evenly shave away at the pencil on all sides.

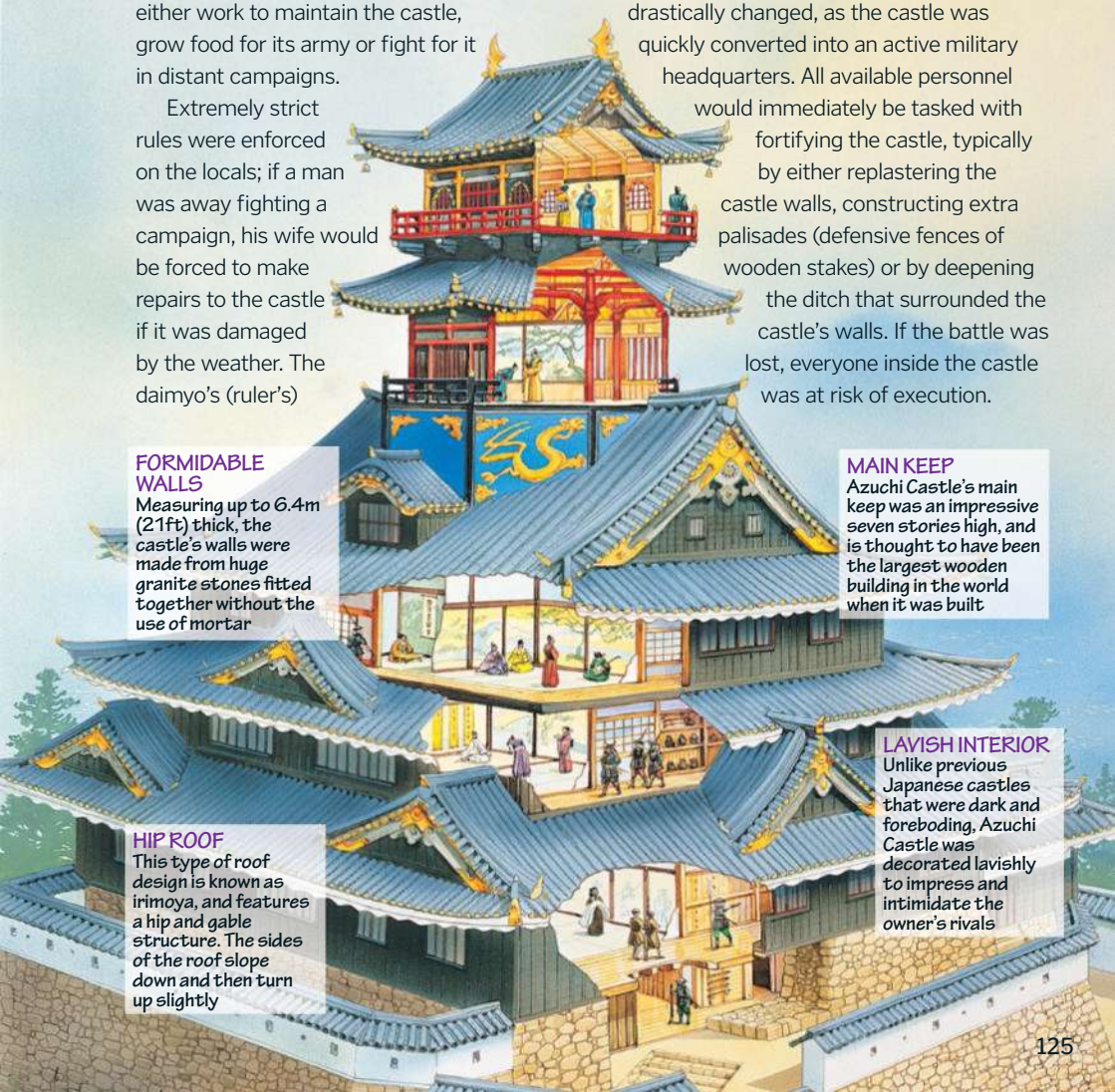
The French may have paved the way, but it was America that made waves. In the 1850s, US inventor Walter K Foster mass-produced a similar cone design and by 1857 his company was cranking out 7,200 sharpeners a day.

Japanese castles were the most important structure during war

A medieval Japanese castle was not only the geographical centre of a ruler's territory; it was also their most important structure. The population relied on the castle to defend them when war began; during times of peace they would either work to maintain the castle, grow food for its army or fight for it in distant campaigns.

Extremely strict rules were enforced on the locals; if a man was away fighting a campaign, his wife would be forced to make repairs to the castle if it was damaged by the weather. The daimyo's (ruler's) needs were always the priority. If a single person failed to complete their task, a punishment would be imposed on the entire company.

When war began, the daily lives of both the garrison and the general population drastically changed, as the castle was quickly converted into an active military headquarters. All available personnel would immediately be tasked with fortifying the castle, typically by either replastering the castle walls, constructing extra palisades (defensive fences of wooden stakes) or by deepening the ditch that surrounded the castle's walls. If the battle was lost, everyone inside the castle was at risk of execution.



FORMIDABLE WALLS
Measuring up to 6.4m (21ft) thick, the castle's walls were made from huge granite stones fitted together without the use of mortar

MAIN KEEP
Azuchi Castle's main keep was an impressive seven stories high, and is thought to have been the largest wooden building in the world when it was built

LAVISH INTERIOR
Unlike previous Japanese castles that were dark and foreboding, Azuchi Castle was decorated lavishly to impress and intimidate the owner's rivals

HIP ROOF
This type of roof design is known as irimoya, and features a hip and gable structure. The sides of the roof slope down and then turn up slightly

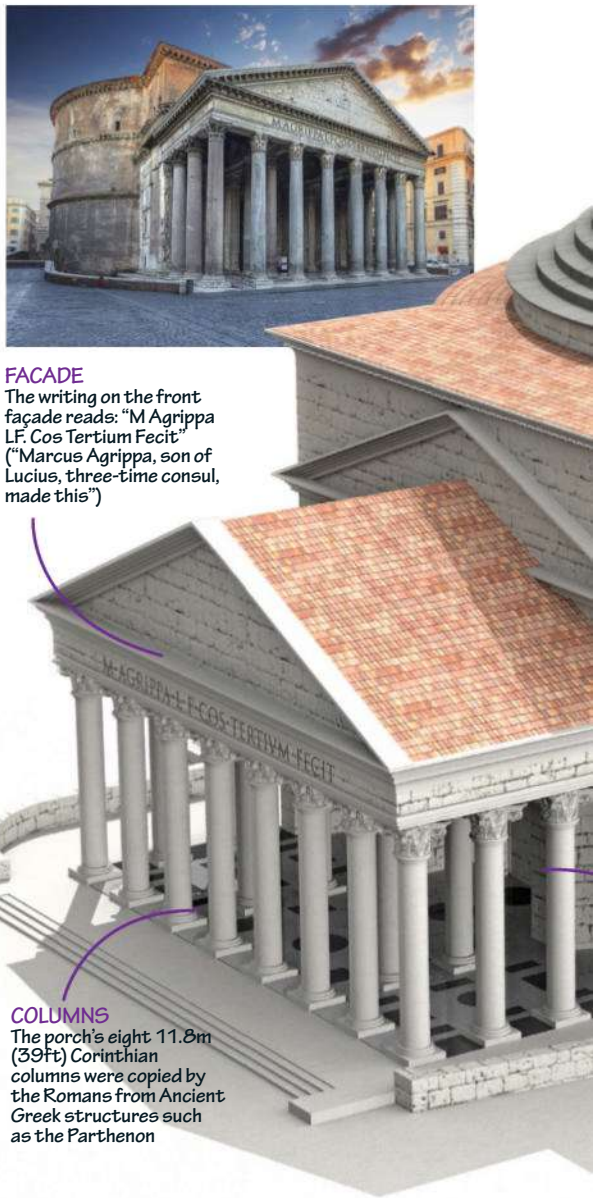
DID YOU KNOW...

The Pantheon has elements of Greek design

You may have heard of the Roman Emperor Hadrian – he has a wall named after him in Northern England – but his most famous and influential project is the Pantheon. Nestled in the heart of Ancient Rome, it is the largest unreinforced concrete dome in the world. It was completed in around 125 CE after the original was burnt to a cinder. The Pantheon served as both a temple to the gods and also as a place where the emperor could make public appearances.

The front of the structure is Greek in style and is not too different from many of the buildings in Ancient Athens in its pomp. The remainder is a classical Roman style and contains an 8.8-metre (29-foot) oculus in the dome. While the Greek columns were made of marble, the Roman arches inside are constructed from brick. The vast dome is held up by internal arches and step rings and signifies a major breakthrough in architecture. These techniques enabled the Romans to build the biggest structures seen in that period.

With the fall of the Western Roman Empire, Europe experienced a period of architectural decline known as the Dark Ages. As cities across the empire were ransacked, many of the great Roman buildings were destroyed by barbarian hordes. Currently, the building serves as a symbolic tomb for the old Italian monarchy and as a constant reminder of the greatness of Ancient Rome.

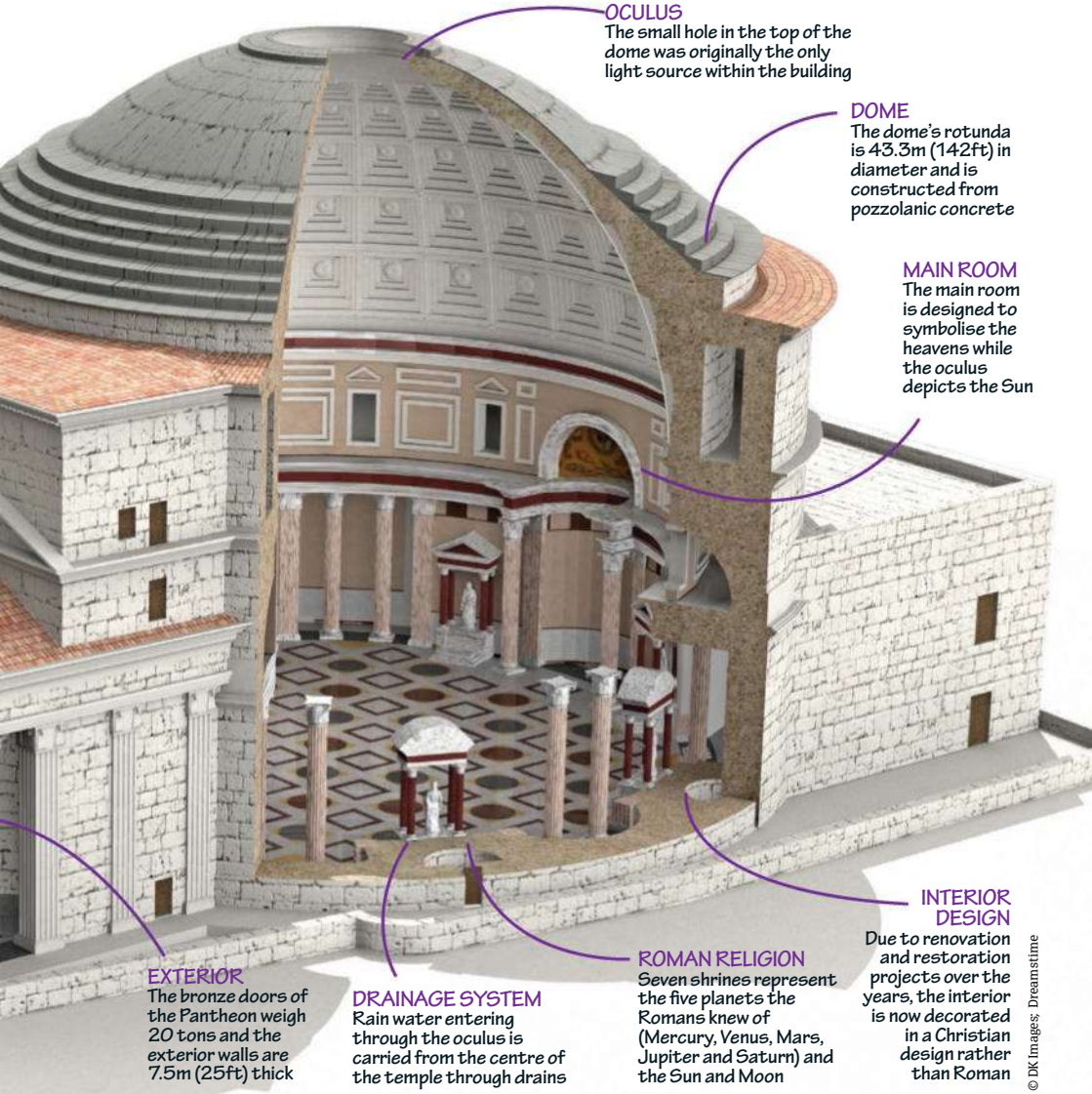


FACADE
The writing on the front façade reads: "M Agrippa LF. Cos Tertium Fecit" ("Marcus Agrippa, son of Lucius, three-time consul, made this")

COLUMNS
The porch's eight 11.8m (39ft) Corinthian columns were copied by the Romans from Ancient Greek structures such as the Parthenon

PRETENDERS TO THE CROWN

From the Panthéon in Paris to the Pantheon of National Revival Heroes in Bulgaria, the legendary structure has influenced building style around the world. You'll notice the symmetrical design with rows of Corinthian columns reproduced in the US Capitol Building and the Jefferson Memorial in Washington, USA, and a little closer to home in the Villa Almerico-Capra in Italy. Ancient Roman architecture has been the template for many structures and since the Pantheon is undoubtedly one of the best preserved of them all, it's only natural to look to it for inspiration. As they say, imitation is the sincerest form of flattery.



From the makers of HOW IT WORKS

THE DRONES BOOK

Discover everything you need to know about one of the hottest gadgets on the market. Packed with essential advice and in-depth guides to how drones are changing the world, this is a must-have for any gadget lover.

Also available...

A world of content at your fingertips

Whether you love gaming, history, animals, photography, Photoshop, sci-fi or anything in between, every magazine and bookazine from Imagine Publishing is packed with expert advice and fascinating facts.

BUY YOUR COPY TODAY

Print edition available at www.imagineshop.co.uk
Digital edition available at www.greatdigitalmags.com

Print Tablet Phone Desktop

HOW IT WORKS

DID YOU KNOW?

Revealing the truth behind life's biggest mysteries

Lady bugs live for up to two years

The future in motion

Ground-breaking science

Pencil sharpeners were French

The world around us

Travel into outer space

Sirens do not flash

Explore the past

Breath-taking technology

Hula-hooping got a Nobel Prize

You can draw in 3D